COMPUTERIZED VEHICLE ROUTING PROGRAMS AND THEIR EFFECT ON VEHICLE UTILIZATION IN THE AIR FORCE

THESIS

Rex E. Adee, Captain, USAF
William G. Howard, Captain, USA

AFIT/GLM/LAL/93S-2

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GLM/LAL/93S-2

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The views expressed in this thesis are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

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THESIS

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Rex E. Adee, B.S.

Captain, USAF

William G. Howard, B.S.

Captain, USA

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Abstract

The purpose of this study is to determine if a commercial computerized vehicle routing program improves vehicle utilization for an Air Force base transportation organization. The study investigates the Material Handling and Relocations Branch of the 645th Transportation Squadron located on Wright-Patterson AFB. First, the researchers investigate current routing procedures of Air Force base transportation organizations. Second, researchers identify a commercial computerized vehicle routing program that enables the authors to conduct a hands-on analysis. Finally, researchers conduct a comparison of vehicle utilization rates between an Air Force base transportation organization and commercial computerized vehicle routing program.

A thorough literature review, personal and telephone interviews, and an actual hands-on analysis of the Air Force manual methods and a computer program determine the effect of implementing a commercial computerized routing program in an Air Force base transportation organization.

The study reveals that implementing a computerized vehicle routing program in place of a manual routing procedure does not improve vehicle utilization. However, the study reveals some limitations that may affect the outcome. The study also provides suggestions for further research of vehicle routing programs in military operations.

COMPUTERIZED VEHICLE ROUTING PROGRAMS AND THEIR EFFECT ON VEHICLE UTILIZATION IN THE AIR FORCE

I. Introduction

Chapter One introduces the research on identifying types of computerized routing and scheduling programs and the potential application these programs have in Department of Defense transportation systems. The following sections contain a discussion of the general issue, research objectives, investigative questions and scope, limitations and assumptions of the study.

General Issue

With the drawdown in forces throughout the military, one of the primary concerns leaders face is the ability to continue to operate efficiently with upcoming budget reductions. These reductions will affect the way business is currently being conducted. For logisticians this translates into fewer vehicles, supplies, and personnel to maintain current operations. The adage of "doing more with less" will be prevalent in the upcoming years. To continue to operate effectively and meet mission requirements, leaders will have to seek innovative approaches. In the Air Force transportation systems, improving vehicle utilization and lowering overall vehicle operating costs are methods that will assist units in operating with reduced budgets.

> From a practical standpoint, the effective routing and scheduling of vehicles and crews can save government and industry many millions a year by increasing productivity, aiding long range planning, assisting in contract negotiations, and in controlling the financial impact of adverse weather conditions on vehicle utilization. (2:97)

There are numerous commercial computer programs that claim to improve vehicle utilization rates and lower vehicle operating costs. Currently there are several commercial transportation companies using these programs with varying degrees of success.

Research Objective

This research determines if a commercial computerized vehicle routing program improves vehicle utilization for an Air Force base transportation organization. The researchers investigated the Material Handling and Relocations Branch of the 645 Transportation Squadron located on Wright-Patterson Air Force Base to compare their current routing practices against routes developed by a commercial computerized vehicle routing program.

Investigative Questions

To answer the research objective the following investigative questions will be answered:

1. What type of vehicle routing procedure does an Air Force Base transportation organization employ?

2. Which commercial computerized vehicle routing

programs are most compatible with Air Force base transportation organizations?

3. What effect does a commercial computerized vehicle routing program have on vehicle utilization rates in an Air Force base transportation organization?

Scope and Limitations of the Study

Although there are several types of commercial computerized vehicle routing programs, this research analyzes only those programs that are most compatible with Air Force base transportation organizations. Specifically, this research is limited to programs that apply to vehicle routing problems in a limited geographical area, operate on IBM compatible systems at least 30 megabytes of hard drive storage, priced below $20,000, and have an available training program provided by the manufacturer.

Summary

There are numerous commercial computerized vehicle routing programs currently on the market with several transportation companies using them. This research studies the effect of utilizing a commercial computerized vehicle routing program in an Air Force base transportation organization.

II. Literature Review

Introduction

Logistics is playing an increasing role in reducing costs and providing improved customer service in a company's business strategy. Since transportation costs typically range between one-third and two-thirds of total logistics costs, improving efficiency through the maximum utilization of transportation equipment and personnel is a major concern (1:483). To reduce transportation costs and also to improve customer service, finding the best routes a vehicle should take to minimize route time or distance is a frequent decision problem (1:483). Computerized routing programs use mathematical and operations research techniques to determine the best assignment of customers to routes and the best sequencing of deliveries within each route in order to save route time and distance.

This chapter discusses the development, level of interaction, and future growth of computerized routing programs. Specifically, this includes information about heuristic methods, uses of computerized routing programs, and factors affecting the future growth of such programs. Applications of commercial computerized vehicle routing programs that focus on increasing vehicle utilization rates, reducing operating costs, number of routes, and route development times are discussed. Additionally, the researchers discuss examples of three commercial computerized vehicle routing programs that are successfully being used in the commercial transportation industry. Finally, the research addresses the current involvement of computer vehicle routing programs in the Air Force.

Computerized Routing Programs

> Routing and scheduling vehicles has been a popular research area over the last 30 years. This is the problem of determining the number of routes, and associated vehicles, needed to serve multiple stops from a central depot, and to determine the best sequence to visit the stops so that the summed distance for all routes is minimized. (2:51)

Heuristic methods were commonly used to solve these problems. In simple terms, heuristic methods are rules of thumb that find a satisfactory, rather than optimal, solution. For vehicle routing problems, heuristic methods can be divided into two categories: 1) methods used for finding initial solutions or 2) methods used for improving solutions once the initial solution is given (13:822). In addition, within the first category, most heuristics that have been developed are largely variations of the traveling salesman problem and can be categorized into three types:

1. savings,
2. cluster, and
3. sweep (2:55-56; 15:112-114; 7:444-446).

The traveling salesman problem is best described in the following example. If a salesman, starting from his home city, is to visit each city on a list exactly one time and then return home, it is plausible for him to select the order in which he visits the cities so that the total distances traveled is as small as possible (1:488-489; 19:1). If we assume he knows the distances from one city to another, then he has all the data necessary to find the minimum, but it is not obvious how to use these data in order to get the answer (19:1).

The savings method assumes that a vehicle is available to be assigned to pick up/deliver at each stop. This means there are as many routes as there are stops. This is the most inefficient solution possible. After all stops have been assigned to a vehicle, two stops are then combined to form one route based on those that give the greatest savings in total distance traveled on all routes. This effectively eliminates one vehicle and route from the solution. This process continues until no more vehicles can be eliminated without violating vehicle capacities. In addition, the sequence of each stop is formed simultaneously as the stops are consolidated on routes. This method allows the user to incorporate restrictions such as pickups, deliveries, and time windows on the same route; time limits for vehicle operation; and multiple vehicle types (2:55-56; 4:127-128; 7:444-446; 15:112-114).

The cluster method determines the stops for each route first and then sequences the stops. Clusters are formed by grouping stops based on their proximity. The number of clusters formed depends on the amount of cargo space available in the vehicles that service a cluster. If the volume of cargo in the cluster exceeds the capacity of a vehicle, or vehicles, servicing the cluster, then some stops must be reallocated to vehicles that have unused capacity. Reallocation depends on unused vehicle capacity and cost. The objective is to eliminate any configurations within stops that split cargo between vehicles. This method is designed to result in lower total distance of routes (2:55-56; 4:127; 7:444-446; 15:112-114).

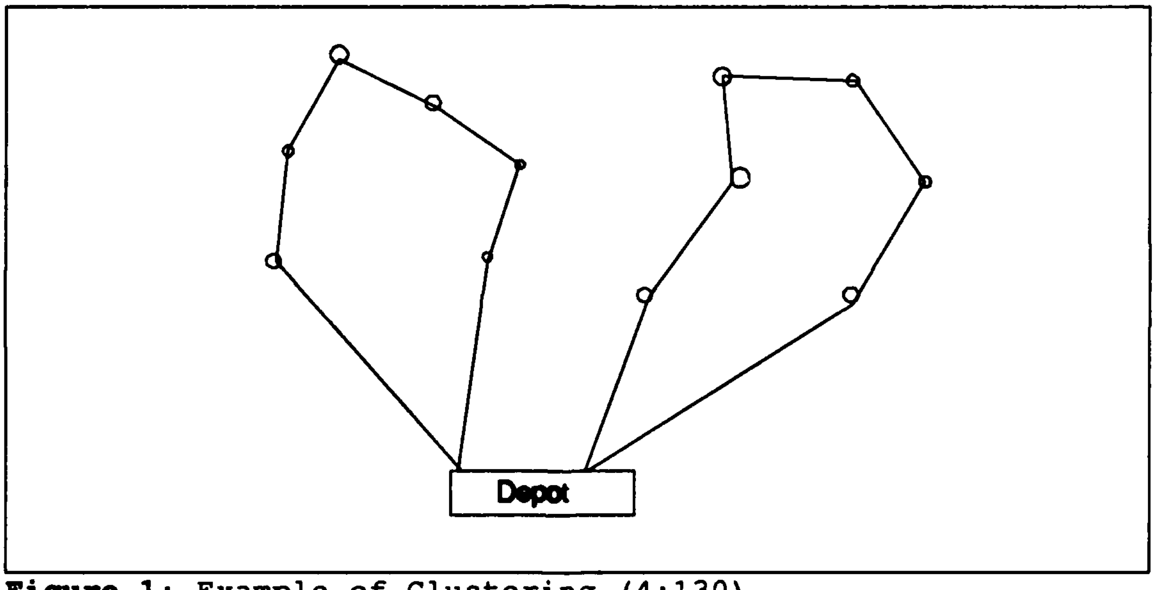

Figure 1: Example of Clustering (4:130)

The sweep method begins by drawing a line out from the depot past the farthest stop. This line is then "swept" counterclockwise to intercept all the stops. When the line intersects a stop, an attempt is made to assign all the cargo to the first vehicle. The sweep continues until the first vehicle reaches capacity or some other restriction is violated at which a new route and vehicle are generated. The rotation continues until all stops have been assigned to a vehicle and the line rotates back to the original starting point. This method allows the user to input constraints such as vehicle capacity, total time on the route, and total distance traveled (2:55-56; 4:127; 7:444-446; 15:112-114).

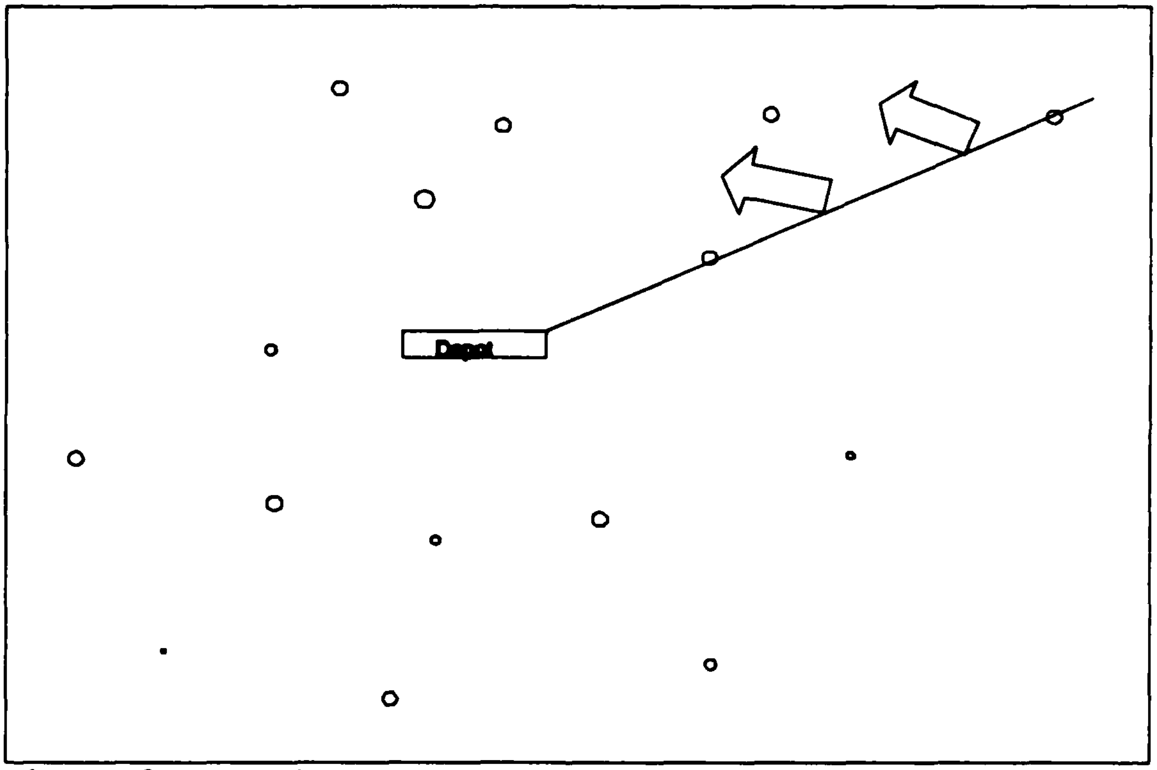

Figure 2: Example of Sweep

The heuristic methods have been helpful in solving vehicle routing problems. In one example, a heuristic method was used in researching a time-sensitive routing problem (11:407). Dr Evans, a professor from the University of Wisconsin who conducted the research, identified the objective of the research as developing a procedure that would produce good solutions to larger and more realistic routing problems where route time is an important factor (11:407). Evans utilized the sweep method to accomplish the objective and tested it on 10 days of transportation data from a large food distributor. The test resulted in overall variable cost savings of 13.2 percent when compared to actual costs (11:414). Cost savings occurred by reducing either fixed or variable costs associated with distribution. Fixed costs related to fleet size, while variable costs related to drivers' pay, depreciation of the fleet, and vehicle maintenance costs (12:468). In addition, the solutions provided by the heuristic method reduced the number of routes for each day (11:414).

The heuristic method of solving vehicle routing problems has been very successful and widely used in research. However, one of the underlying limitations for heuristic methods is that heuristic procedures usually stop at the first satisfying solution (13:822). For this reason and in order to deal with the issues that arise in more complex and realistic routing problems, i.e., multiple vehicle types, multiple commodities, and more customers, computerized vehicle routing programs were developed.

Since 1979, dramatic changes in vehicle routing programs have occurred. Not only have algorithmic techniques been developed for the more complex vehicle routing problems, but realistic model formulations have been developed. Computerized vehicle routing programs can be categorized into two types 1) optimization and 2) heuristics-based. Optimization is where the problem is broken down into mathematical expressions and then the best solution is found through the application of mathematical logic. This approach has limitations, however. In order to ensure arrival at the best solution, significant computer run time and memory are required. This often causes real-world problem descriptions to be abbreviated and approximated. Detail must often be sacrificed to allow for enough processing time to find the best solution (3:123-125).

Heuristics-based programs use rules-of-thumb that find a satisfactory solution. Quality heuristics will allow for a near optimal solution to be found in a fraction of the processing time required for optimization. Given the problem of most day-to-day operations where decisions must be made in a short amount of time, finding a good solution, rather that optimal, may be satisfactory. "Often times, there is only a small difference between an optimum solution and a wide range of good solutions" (3:125). Since this is the case, the use of heuristics-based programs may be the practical choice when considerations such as decision time and computer storage are important (3:123-125).

As a result of the differences between the two categories of computerized vehicle routing programs, the researchers limited the study to heuristics-based programs due to the computer capability and requirements of Air Force base transportation organizations. Although there are now several variations of heuristics-based programs designed to solve numerous routing problems; overall the programs are primarily used to maximize vehicle utilization, address particular constraints, and lower overall transportation costs (8:109).

Future Growth of Computerized Vehicle Routing Programs

Indications are that increased use of computerized routing packages in transportation companies will not slow down. The ready availability of microcomputer-based routing programs has already lowered the cost of implementing a computerized routing program. In 1983, available computerized routing systems were made for mainframe computers and cost as much as $100,000. Now programs for the microcomputer cost between $500 and $50,000 (11:804). As a result in lower costs, improved programs are being developed as investors are willing to fund start-up companies to develop and market these programs. These improved programs are being developed with more realistic models and algorithmic approaches that can handle variations that occur in dynamic environments. For example, commercial routing programs can now handle time windows, overtime, crew breaks, pickups and deliveries, and mixed types of vehicles or multiple commodities (11:804). The advances in the hardware/software technology, and the availability of more detailed geographical databases will also influence the improvement in computerized routing programs. As processors become faster and cheaper, graphics are enhanced, and more detailed geographical databases for computers become available, computerized routing programs may be developed quicker to meet the increased demand (17:808).

A potential problem with the increase in implementation of improved computerized routing systems, "is a tendency to remove humans completely from the decision making" (31:821). This could negatively impact the operation of a company because removing the human element ignores any contributions which experienced dispatchers make. Experienced dispatchers know the peculiarities not only of routes but also of drivers. These types of information are ones that cannot easily be programmed into a computer. For example, one of the drivers is not very good at backing a tractor and trailer. The computer assigns him to a route with stops that require a lot of backing. The dispatcher can override the computer solution based on information he knows that cannot be realistically programmed into a computer. Computers are useful tools but they should not be relied on in making decisions automatically in complex and difficult situations (31:821).

A better way to approach computerized routing programs is to combine the unique skills of both human dispatcher and computer. This involves interactive processing between dispatcher and computer where the dispatcher makes decisions and the computer calculates results of the decisions, stores the results, compares the results with previous decisions, and makes suggestions based on internal algorithms (31:822).

There are already a small number of commercial computerized routing programs that use interactive processing. In one study, routes from standard test problems indicate that using an interactive routing program can give good results. When interactive routing programs were implemented, the routes were determined to be more satisfactory than those obtained by other methods (31:825).

Applications of Computerized Routing Programs

This section discusses four case studies that concern vehicle utilization, operating costs, number of routes, and route development times. These case studies are intended to give an overview of how computerized vehicle routing programs can be adapted to a variety of routing problems.

Fisher and Greenfield, 1982 (14). This case study describes a project at DuPont which utilized state-of-the-art computerized routing methods that reduced delivery costs for a major product by over 15 percent. This project involved assigning over 1500 customers to about 50 routes.

The product involved in the project was the automatic clinical analyzer (ACA) which was a machine that automated many of the routine tests made for patients in medical laboratories. Consumable chemical products are required to operate an ACA. These chemical products had to be refrigerated and delivered to customers through regional distribution centers.

During the initial stages, the chemical products were delivered to over 1500 customers located in about 1000 cities throughout the continental United States and Canada. As the amount of customers rapidly continued to grow, managers at DuPont were concerned with the expanding delivery costs. This resulted in a study being conducted to find an alternative method to reduce distribution costs.

The distribution system for the chemical products included facilities, trucks, and delivery routes. Within the facilities the product flowed from the plants to the regional distribution centers to the truck terminals. The company used two types of trucks. The large tractor-trailer were used to move the product from plants to regional distribution centers and on to the truck terminals. Medium sized flat-bed trucks were used to deliver the product to customers. There were three alternative route selections. The most common selection, called Direct Refrigerated Delivery (DRD), an internal carrier, was used to deliver the product by driving weekly loops to several customers. Each customer typically received a delivery once a month. The second alternative used an outside carrier such as air freight or motor-freight. The third alternative involved transshipment from a DRD truck to another carrier that delivered the product. The major costs associated with the routes were fuel, truck depreciation, and driver wages.

Several constraints were considered in designing loops: the volume of products to be delivered on the loop could not exceed the truck capacity, delivery service policy only permitted daytime delivery five days a week, and drivers were limited to a maximum of 10 hours of driving per day. The goal of the redesign process was to create loops that minimize fuel cost, driving time, and vehicle depreciation based on the established criteria. Prior to the study, the design of loops was done manually.

To solve the problem, a project team employed a computerized routing program called ROVER (Real-Time Optimizer for Vehicle Routing). This basic program existed in 1979 and was designed to schedule a vehicle fleet that delivered products stored at central depots. Using input data, ROVER determined which customers were assigned to each vehicle and in what order customers received products. The goal was to minimize total travel costs.

Numerous features were added to ROVER since its inception in 1979. These include the ability to schedule from multiple terminals, constraints on time duration of a vehicle route, multiple capacity constraints such as weight and volume, and time window constraints when customers receive deliveries. This resulted in very low cost solutions to tightly constrained problems involving truck utilizations as high as 99 percent of capacity.

The project was conducted in two phases. Phase One used a basic version of ROVER to demonstrate the feasibility of computerized vehicle routing. Phase Two, which is still in effect, was used to establish semi-annual customer loop assignments and evaluated proposals for any needed changes. The reduction in delivery costs as a result of implementing ROVER were approximately 15 percent.

Evans and Norback, 1985 (12). In this study, Evans and Norback developed and implemented a computer based distribution decision-support system (DDSS) at Kraft Inc. The situation was that a fleet of vehicles operated from a single depot delivering products to a known number of customers at known locations. DDSS was designed to aid a dispatcher in accomplishing efficient vehicle routing.

Evans and Norback faced several challenges in developing this system. First of all, customers were not ordering on a fixed schedule. Next, the time to fill an order was as short as one day, possibly even less for rush orders. There were also strict restrictions on both weight and volume of products the vehicles were allowed to carry. Finally, the company also restricted the route times and the balance of work-load between drivers.

There were two objectives in implementing DDSS: 1) it provided the dispatcher a tool to quickly evaluate and modify, if needed, a proposed solution and 2) it enabled the dispatcher to find opportunities to save costs in proposed solutions.

Previously, routes were devised by breaking each distribution region into sub-regions which equated to one truck. Routes were developed based on the deliveries to customers assigned to the sub-regions. Customers were served according to the order in which they appeared on the computer printout without regard to location. The dispatcher changed the routes when the weight and/or volume restrictions for a truck were violated.

The new approach also started with the list of deliveries to customers assigned to the sub-regions. The computer then sequenced the stops using the sweep method. Once the routes were developed, the dispatcher could interactively make changes to the routes based on personal experience/knowledge about a customer or route. It also allowed the dispatcher to balance work load between drivers while not violating the restrictions on weight and volume.

DDSS was initially tested at Kraft using data from 10 consecutive working days of previous deliveries. A decrease of 10.7 percent of the actual cost was realized by using DDSS to develop the routes instead of the previous method.

Evans and Norback report that the cost savings were only part of the benefits as a result of using DDSS. They said that possibly even more important were benefits gained from the interaction between the dispatcher and computer. It required a human to "evaluate tradeoffs between costs and fair work loads or between costs and a special delivery to an important customer" (12:471). The ability to interact also allowed late orders, vehicle breakdowns, road detours, and other unforeseen changes to the routes to be made.

Powell and Sheffi, 1988 (24). In a joint project carried out at Princeton University and the Massachusetts Institute of Technology, a computer package, known as APOLLO (Advanced Planner of LTL Operations) was developed to solve load planning problems for PIE Nationwide, a trucking company that operates with over 300 terminals throughout the United States. This computer package also is used in the end-of-line terminals to develop routes for local deliveries.

The load planning problem at PIE was an exercise to determine the routing of shipments through a breakbulk terminal to final destination. The results of the load plan was to determine how trucks were routed and how a freight movement plan (FMP) was developed. The FMP specifies how to route individual shipments.

Usually trailers were loaded at one terminal and completely unloaded at the end-of-the line terminal. If the end-of-the-line terminal for a trailer was not the final destination for a shipment on that trailer, the shipment was sorted and reloaded onto a local delivery trailer. The load plan specified which local delivery trailer was used for the shipments. This load plan applied to less-than-truckload (LTL) freight.

To understand the load planning problem it is necessary to comprehend some elements of LTL operations. A LTL network consists of end-of-line terminals, where breakbulk operations unloads, sorts, and reloads freight from one trailer to the next. When a trailer is loaded at terminal *i* and unloaded at terminal *j*, this is called direct service from *i* to *j*. Once the trailer at terminal *j* is unloaded, the freight is sorted and redirected to trailers delivering in the local area.

APOLLO provided managers and dispatchers with the automated capability to route shipments through breakbulk terminals all the way to the customer. The impact was immediate cost reductions due to an improved load plan and also a fundamental change in the PIE approach to network planning. Overall, PIE headquarters estimated an annual savings of 7-10 million dollars in transportation costs (out of a total operating cost of 400 million dollars). APOLLO also had tremendous impact on fundamental planning and operating practices at PIE. As a result, confidence has been restored in the field managers with an improved enforcement of policies in the company.

<u>Sutcliffe and Board, 1990</u> (28). This study, through the use of a computerized routing program, looked at providing an optimal solution to the problem of transporting mentally handicapped adults to a training center. The problem involved a service center for mentally handicapped adults and an adult training center (ATC). The service center provided free transportation for the mentally handicapped adults (students). The total number of students transported was 44. The service center had available three large, identical transit minibuses and one ambulance with a tail-

lift that transported the students. The ATC manager devised the vehicle routes by hand prior to this study.

The following data were gathered: distances, travel time, capacity, and trip times. Distance involved the actual miles that had to be traveled from the service center to students residence to the ATC. Travel times were estimated by converting the distances into time by using estimated speeds for the different areas of the region covered. Capacity was just the capacity of the different vehicles. Trip times included the time the students took to board the vehicles in the morning and the time to leave the vehicles in the evening.

A program was developed and implemented to devise vehicle routes. As a result of this program, "the optimal solution achieved a reduction of 15.7% in the total travel time" (29:66). In addition, total mileage was reduced by 11.5 percent.

Current Commercial Programs

Microanalytics Corporation has developed a routing program called Truckstops which uses a combination of features in determining distance and time for routes. These features include scaled straight line, barriers, and true time and distance files. The use of these features enables Truckstops to require less processing time to determine routes (28:1).

Truckstops from Microanalytics is currently being used by over 1,000 users who report savings of five to thirty percent in transportation costs. In fact, Simmons Co. has been able to reduce the number of tractors and trailers in its private fleet by more than one third while achieving a ninety-nine percent on time delivery performance (1:53).

Yellow Freight, Inc. has been using various types of computerized vehicle routing program for around ten years. Their current program (TRACS) was developed by Yellow Freight personnel using technology acquired from other vendors. By combining unique features of various programs, Yellow developed an in-house program that catered to their particular vehicle routing requirements.

Yellow Freight, Inc. has already realized savings in implementing TRACS in their terminals. In Chicago, for the month of October 1991, they realized a total cost savings of $18,747.70. In Sacramento, for the same month, they realized a total cost savings of $14,428.04. In fact, Sacramento had shown a savings in 1991 (Jan-Oct) of over $80,000 (16:4-8).

Leaseway Technology Corp., a subsidiary of Leaseway Transportation, developed a vehicle routing program (RouteAssist) that utilizes heuristics and is flexible enough to handle many diverse operating environments. A few of the system features provide an easy-to-use, menu-driven, screen based system for data entry and modification; an economic analysis of common versus contract or private carriage; allows for both pickup and delivery stops on the same route; accommodates time windows; sets maximum distance or length of time spent on route; allows for multiple vehicle speeds for different types of roads; and estimates driving distances using 5 digit zip codes (26:3).

Ladd Transportation, a subsidiary of Ladd Furniture, Inc., has been using RouteAssist since 1984. Within a year of implementation, Ladd Transportation increased internal deliveries by 28 percent and profitability by 10 percent. Even though Ladd Transportation does not use RouteAssist to replace their traffic managers, it can definitely enhance the effectiveness of the traffic managers (30:163).

Air Force Involvement in Computerized Routing Programs

The researchers conducted telephone interviews with Maj Mike Kane and CMSgt Phil Hobson of HQ USAF/LGTV concerning computerized vehicle routing programs. According to them, there is no research being conducted in computerized vehicle routing at this time. In addition, there are no Air Force transportation organizations currently using computerized routing programs. All transportation organizations are routing their vehicles based upon individual dispatchers' knowledge and experience (18; 21).

Summary

This chapter provides the results of an extensive literature review. Heuristic methods lay the foundation for a discussion of reasons computerized vehicle routing programs developed. The aspects of computerized vehicle routing programs are described including their various uses for managers and increasing demand in the transportation industry. Next, the researchers present four case studies that discuss some of the applications and benefits derived from computerized vehicle routing programs. This was followed by three examples of commercial computerized vehicle routing programs that had documented measures of success in the transportation industry. Finally, the researchers discuss the current involvement and interest in computerized vehicle routing programs in the Air Force.

III. Methodology

Introduction

This chapter describes the methodology required to solve this research problem. Various research methods such as published research reviews, telephone and personal interviews, and actual implementation of a computerized vehicle routing program are used to answer the investigative questions posed in Chapter I. Each investigative question is addressed separately in this chapter.

Investigative Questions

1. What type of vehicle routing procedure does an Air Force base transportation organization employ? In order to determine what procedure a transportation organization employs, the researchers conducted various inquiries with different agencies in the Air Force transportation field.

The first step in determining the routing procedures is to review any regulations or policies concerning base transportation operations. This method provides general instructions of base transportation operations in the Air Force. Next, the researchers interviewed the dispatch supervisor for 645 TRNS on Wright-Patterson AFB to determine how a base transportation organization routes vehicles. Third, brief interviews with fellow Air Force Institute of Technology students were conducted. This allowed the researchers to draw experience from students who came from various worldwide locations. Finally, the researchers telephonically contacted experts in the transportation field at HQ USAF, HQ ACC, and HQ PACAF to seek their opinion on the current base transportation routing procedures.

The review of regulations and policies, and the responses of the telephone and personal interviews allowed the researchers to construct generalizations on the type of vehicle routing procedures employed in an Air Force transportation organization.

2. Which commercial computerized vehicle routing programs are most compatible with Air Force base transportation organizations? To identify which commercial computerized vehicle routing programs are most compatible, the researchers first determined a base transportation organization is limited to a specific geographic area around the Air Force base in which it is operating. This determination was based on established procedures that all Air Force base transportation organizations follow (9).

The researchers then searched the industry literature and sought opinions from experts in the commercial field of vehicle routing to determine the commercial computerized vehicle routing programs currently in use.

> There are various types of vehicle routing programs in the market. Some programs are internally designed to meet the needs of the company, others are more generic. Programs that solve vehicle routing problems within a limited area can be found in local haul transportation companies. Also, companies that deliver bread on a daily basis and companies that provide school bus service use these programs to minimize distance and operating time. (29).

The researchers initially contacted two local transportation companies in the Dayton area (Victory Trucking, Inc. and United Parcel Service) to obtain information on the type of vehicle routing program they used. Representatives from both companies were reluctant to discuss any details of the vehicle routing program they used, but a transportation supervisor at Victory made a suggestion to call Microanalytics Corporation in Annandale, Virginia.

Microanalytics Corporation specializes in computerized vehicle routing programs and is considered a leading expert in the field. They, in turn, shipped the researchers a copy of the 1992 Distribution/Computer EXPO Handbook. This handbook provides the user with an extensive listing of various automation products for distribution and transportation. Among the listings is a section on routing and scheduling which the handbook describes as "the shortest, fastest, or optimum distances for developing routes and minimizing the number of vehicles to run those routes" (8:97). Pages 97-104 of the handbook contained 38 listings of various types of commercial computerized vehicle routing programs.

A purposeful judgement sampling was used to select the commercial computerized vehicle routing programs from the handbook obtained from Microanalytics Corp. The purposeful judgement sample "occurs when a researcher handpicks sample members to conform to some criterion" (10:275).

To establish valid criteria, the researchers developed a list of considerations that a base transportation officer would use if he were buying a commercial computerized vehicle routing program. The criteria included programs that applied to vehicle routing problems in a limited geographical area, operated on IBM compatible systems with at least 30 megabytes of hard drive storage, priced below $20,000, and had an available training program provided by the manufacturer. Information for this list was founded on the researchers' experience in base transportation operations. To ensure the contents of the list were valid, the researchers used "a panel of persons to judge how well the instrument [the list of considerations] meets the standards" (10:180). The researchers contacted various experts in the transportation field at HQ USAF, HQ ACC, and HQ PACAF. Maj Mike Kane, Lt Col Worthey Briscoe, and Lt Col Brian Kerins were contacted by telephone because of their expertise in base transportation operations. Each officer was given a short briefing on this study and asked to comment on the list of considerations. All three officers agreed that the list of considerations were valid and would apply to a base transportation organization.

Based on these considerations, the researchers identified three computerized vehicle routing programs: Truckstops, TRACS, and RouteAssist. The researchers conducted telephone interviews with the manufacturers of these programs to acquire further knowledge about the programs and to identify a sample of civilian transportation companies that use the selected programs.

The researchers chose telephone surveying to gather the information because of its speed, low cost, and high response rate (10:331). This method was also instrumental in allowing the researchers to interview the system's expert for each of the programs selected. However, there are some disadvantages to telephone interviews. Obviously, the respondent must be available by phone. Once phone contact is established, the interview should not take any more than 10 or 15 minutes of the respondent's time. This method is shorter than other methods, but was satisfactory for the researchers to gain the appropriate information necessary to select transportation companies that utilized the selected routing programs.

The researchers were primarily interested in transportation companies that were within short driving distance of the Air Force Institute of Technology in order to conduct personal interviews with operators of these programs. The researchers chose personal interviews because

> ... it far exceeds the information secured from telephone and mail surveys. In addition, interviewers can note conditions of the interview, probe with additional questions, and gather supplemental information through observation. (10:320)

The researchers identified three commercial transportation companies in the state of Ohio that currently use Truckstops, TRACS, and RouteAssist. They are Consolidated Freight, Inc.; Yellow Freight, Inc.; and

Leaseway Transportation, Inc., respectively. The researchers made personal visits to each of these companies and interviewed the transportation manager responsible for the operation of their computerized vehicle routing program.

Before the interviews were conducted, the researchers developed a generalized list of requirements. The list of requirements was constructed to ensure the researchers obtained, at a minimum, certain information required to further the study. The two major questions in the interview were the overall performance of the vehicle routing program and the ease of implementation. These two questions allowed the researchers to gather data on overall cost reduction and to personally observe the system in operation to determine which vehicle routing program could be used in an Air Force base transportation organization. Each transportation manager was telephoned and a personal interview date and time was established.

While conducting these personal interviews, the researchers discovered the best method to determine a commercial computerized vehicle routing program's applicability in an Air Force base transportation organization is a hands-on evaluation of a base transportation organization using an actual computerized vehicle routing program. Based on this, the researchers opted to use the RouteAssist program from Leaseway Technology Corporation, a wholly owned subsidiary of Leaseway Transportation.

3. What effect does a commercial computerized vehicle routing program have on vehicle utilization rates in an Air Force base transportation organization? To determine if a commercial computerized vehicle routing program can effectively improve vehicle utilization in an Air Force base transportation organization, the researchers compared actual routing procedures developed by the Material Handling and Relocations Branch (MHRB) with those developed by RouteAssist. The routing procedures of both MHRB and RouteAssist were used to ascertain vehicle utilization rates. MHRB represents an Air Force transportation organization that specializes in local area delivery operations and, due to its location, allowed the researchers to conduct a hands-on analysis.

MHRB performs a variety of transportation, delivery, and distribution functions on Wright-Patterson AFB. This includes relocations, deliveries, receiving, and special tasks. MHRB relocates large furniture and equipment throughout the base for several major units on Wright-Patterson AFB. They also deliver office equipment, office furniture, electronic equipment, and copier paper. In the receiving department, MHRB off loads an average of 10 trucks of various sizes everyday. These vehicles come from base supply, commercial vendors, or contractors from out of state. The freight is unloaded, checked for damage, processed for delivery to the customer, and finally delivered to its destination. They also provide manpower and vehicle support for the following: retirement ceremonies, air shows, Air Force museum projects, and contractors. Currently, there are 13 employees and 17 various types of vehicles assigned to MHRB.

Personal interviews were conducted with the supervisor of the Material Handling and Relocations Branch to determine exactly how he routes the branch's vehicles on a daily basis. MHRB delivers approximately 23 skids of copier paper per month. This equates to 1307 boxes of paper that are delivered to various agencies in Area B on Wright-Patterson AFB. This operation is conducted over a three day period each month. The researchers determined that the branch's monthly delivery of copier paper in Area B should be used in this study as it paralleled the traveling salesman problem.

The authors gathered pertinent information on the delivery of copier paper from the supervisor using a data collection form provided by Leaseway Technology Corp. to more effectively collect data needed for the RouteAssist program. In addition, the researchers obtained a map of Area B to identify all the customers/stops on the map. A distance matrix was developed to determine distances between all customers.

This information was collated and input into RouteAssist. Using the manual routing capability of the program, the original routes were replicated. The RouteAssist program was then run to automatically compute the routes and stop sequences.

The researchers did a comparison of the routes developed by the branch and RouteAssist to determine the differences in vehicle utilization rates. Additionally, the researchers analyzed the qualitative aspects of routing procedures that only the supervisor could determine.

Summary

This chapter described the methodology used to answer each of the investigative questions. The findings of each question are reported in Chapter IV. The conclusions drawn on the findings of this study on the effect of a commercial computerized vehicle routing program on vehicle utilization rates in a Air Force base transportation organization along with recommendations for further research are reported in Chapter V.

IV. Findings

Introduction

This chapter describes the findings for each investigative question. Each investigative question is addressed separately in this chapter.

Investigative Questions

1. What type of vehicle routing procedure does an Air Force base transportation organization employ? The researchers conducted a personal interview with Mr. Richardson, who is the supervisor of dispatch operations for the 645th Transportation Squadron at Wright-Patterson AFB, OH. Mr. Richardson provided the researchers with AFR 77-310, Vehicle Operations Management and Use of Motor Vehicles, Vol I. He acknowledged this regulation is the major guideline for vehicle operations in the Air Force. After extensive review of AFR 77-310, the researchers found no specific directions or guidance for transportation managers or dispatchers to use in routing vehicles (8). Mr. Richardson confirmed this fact and stated that he had never seen any regulation or policy that specifically addressed vehicle routing procedures. He also added that it is most common for the dispatcher and driver to collectively determine the best route using a road map along with the past driving experiences of both individuals (25).

Next the researchers interviewed a group of AFIT transportation students that included eight junior transportation officers. Each of these students have varying backgrounds in vehicle operations. Although there were some discrepancies between the students' responses on vehicle operations at various Air Force bases, they mutually agreed that it was the responsibility of the dispatcher to manually route the vehicles. They also agreed that computerized vehicle routing programs were not currently being used in base transportation organizations.

Lt Cols Worthey Briscoe and Brian Kerins, HQ ACC/LGT and HQ PACAF respectively, and Maj Mike Kane, HQ USAF/LGTV, also confirmed that it is the responsibility of the vehicle operations supervisor and the dispatcher to develop routes for their respective operations. In addition, the individuals stated they were not aware of any organizations using computerized vehicle routing programs. They also added that computerized vehicle routing programs would be beneficial to base transportation organizations not only to improve efficiency, but to save operating money (6; 21; 23).

<u>2. Which commercial computerized vehicle routing programs are most compatible with Air Force base transportation organizations?</u> Personal interviews were conducted with the transportation managers at Yellow Freight, Inc.; Consolidated Freight, Inc.; and Leaseway Transportation. While conducting these interviews, the researchers discovered the best method to determine if a commercial computerized vehicle routing program is applicable in an Air Force base transportation organization

is a hands-on evaluation of a base transportation organization using an actual computerized vehicle routing program. The researchers opted to use the RouteAssist program from Leaseway Technology Corporation, a wholly owned subsidiary of Leaseway Transportation.

The researchers chose RouteAssist for two major reasons. One, RouteAssist allowed the researchers to replicate the routes and stops that were used by the Material Handling and Relocation Branch. This replication enabled the researchers to compare routes developed by the branch and routes developed by RouteAssist. The other two programs, Truckstops and TRACS, did not provide this capability. Two, Leaseway Technology had already developed a student version of RouteAssist which allowed universities to use the program in research. They provided the researchers a copy of the student version to conduct this research. This version limits the number of customers and routes but these limitations exceeded the requirements needed for this study.

RouteAssist is a personal computer based decision support system designed to assist dispatchers with daily vehicle routing problems. A standard vehicle problem may be defined as follows:

Given,

1) a centrally located depot, where an unlimited number of vehicles with known capacities are located,

2) a set of customers with known demands and locations,

3) a set of operating constraints i.e., time window, distance restriction, etc.

Find,

1) which vehicle should be assigned to each customer, and

2) in what sequence and at what time the customers on a vehicle are served, so that all the customers are served, all operating constraints are satisfied, and the total cost is minimized (27:25).

RouteAssist is also designed to perform functions beyond a standard vehicle routing problem. Three major subsystems, input data, mathematical model, and output reports, are used to formulate and solve various routing problems.

The input data system is the subsystem where the user primarily interacts with RouteAssist. It handles all the input data needs, is menu driven, has a comprehensive error checking capability, and provides help messages to minimize input errors. The mathematical model provides solutions that are very close to the optimal solution given realistic operating parameters. The output reports provide a detailed route report showing how each route has to be executed, a managerial summary report, a parameter summary, and a list of customers and vehicles used.

RouteAssist was chosen for its ability to adapt to any routing problem. It allowed the operator either to use the parameters set forth in the program or to completely reformulate parameters required to solve a particular problem. In addition, this program allowed the researchers to analyze and compare current base routing practices with those developed by RouteAssist.

<u>3. What effect does a commercial computerized vehicle routing program have on vehicle utilization rates in an Air Force base transportation organization?</u> The researchers conducted personal interviews with Mr. E.K. Karambelas and Mr. Glen Holt of the Materials Handling and Relocation Branch (MHRB) to determine the current method of routing. Mr. Karambelas and Mr. Holt are the supervisor and assistant supervisor respectively of MHRB. They are responsible for developing routes and sequence of stops to fulfill daily commitments. Mr. Karambelas noted that due to continual last minute additions/deletions of daily commitments, they develop the routes the evening prior to the run and, occasionally, change the routes due to additional changes (22).

The routing for the copier paper delivery is not as complex as routing for daily commitments although the procedure is the same. Routes and stop sequences are developed based on distance between stops, location of stops, number of deliveries at each stop, and number of vehicles available. Once each stop location is determined, it is plotted on a base map. This presents a visual representation for Mr. Karambelas to use so that he can cluster stops together. Using the cluster method, he assigns each stop to a route until all stops are assigned. This method results in 13 routes using one 1½ ton truck.

To compare the current method with the routes generated by RouteAssist, a RouteAssist data collection form was used to gather general information about the organization. Leaseway Technology Corp. provided this data collection form that was used to more effectively collect and organize required input data from MHRB (Appendix A). Due to the scope of MHRB, it was not necessary to collect data in every category on the form. The major concerns for this study were categorized into stop data, truck data, and general problem data. Stop data include a list of customers, location (building and room number), demand quantity, and hours of operation (delivery time window). Truck data include types of vehicles, capacity, and operating costs. General problem data include driver wages, depot operating hours, break and lunch policies, vehicle speeds, and local area distances. This information was input into the program as general policy information. The stop data were then gathered using a listing of customers and actually following the delivery truck on its routes. This ensured the customers were assigned to the correct stops. MHRB has 88 customers which are assigned to 37 stops (Appendix B).

Next, the researchers developed a distance matrix (Appendix C). This was done as all stops are in the same zip code. Although the program can calculate distance by zip codes, to distinguish between stop 1 and stop 37 in the same zip code requires a distance matrix. This distance matrix was developed using an Area B base map obtained at the visitors' center at gate 1 on Wright-Patterson AFB. Distance was measured from the warehouse to each stop and also from one stop to another stop. Because of the size of the base, most distances from the warehouse to each stop and from one stop to another stop were less than one mile. While developing this matrix, the researchers discovered a couple of limitations in RouteAssist. First, the distance input into the program must be in whole numbers rather than fractions. The researchers used the standard rounding practice to overcome this limitation. Second, RouteAssist automatically records any distance less than one as one. These two limitations result in an approximation in the distances involved in the routing procedures. However, this is a common practice among computerized routing programs as they use either zip codes or whole number distances to develop routes (8, 20, 28).

Once the distances had been successfully input, the researchers replicated the routes developed by MHRB using the manual routing option in RouteAssist. The summary report produced by RouteAssist (Table 1) for the original 13 routes shows a vehicle utilization rate of 84 percent. The routes with all stops identified are shown in their entirety in Appendix D.

TABLE 1

SUMMARY REPORT FOR ORIGINAL ROUTES

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

*** ROUTE SUMMARY ***

	ROUTE						TIMING				UTIL. (%)		COST
# STP	MILES TRAV-ELED	VEH TYP	BEGIN RTE DAY	BEGIN RTE TIME	END RTE DAY	END RTE TIME	TOTAL TIME	DRIVE TIME	WAIT TIME	ONDUTY TIME	(BOX)	( )	TOTAL COST $
6	8	1	2	7:30A	2	10:55A	3:25	0:25	0:00	3:25	100	0	54
1	2	1	2	7:30A	2	8:49A	1:19	0:06	0:00	1:19	53	0	20
1	2	1	2	7:30A	2	8:58A	1:28	0:06	0:00	1:28	60	0	22
1	4	1	2	7:30A	2	9:11A	1:41	0:14	0:00	1:41	64	0	27
1	4	1	2	7:30A	2	9:34A	2:04	0:14	0:00	2:04	83	0	32
8	9	1	2	7:30A	2	11:01A	3:31	0:27	0:00	3:31	87	0	57
4	6	1	2	7:30A	2	10:19A	2:49	0:19	0:00	2:49	92	0	44
2	5	1	2	7:30A	2	10:04A	2:34	0:17	0:00	2:34	98	0	40
3	6	1	2	7:30A	2	10:19A	2:49	0:20	0:00	2:49	99	0	44
3	5	1	2	7:30A	2	10:16A	2:46	0:16	0:00	2:46	100	0	42
2	3	1	2	7:30A	2	9:49A	2:19	0:09	0:00	2:19	92	0	34
2	16	1	2	7:30A	2	10:13A	2:43	0:53	0:00	2:43	75	0	53
3	9	1	2	7:30A	2	10:14A	2:44	0:29	0:00	2:44	88	0	46
37							32:12		0:00		D 84	0	514
	79							4:15		32:12	P 0	0	

*** SUMMARY STATISTICS FOR PRIVATE FLEET ***

TOTAL NUMBER OF ROUTES:		13	AVERAGE MILES/ROUTE:		6
TOTAL NUMBER OF LUNCHES:		0	AVERAGE STOPS/ROUTE:		3
TOTAL NUMBER OF LAYOVERS:		0	AVERAGE COST/ROUTE:	$	40
TOTAL DEMAND SHIPPED: (BOX)		1307	AVERAGE COST/MILE:	$	6.51
TOTAL DEMAND SHIPPED: ( )		0	AVERAGE COST/STOP:	$	14
TOTAL NUMBER OF LOADED MILES:		55	AVERAGE COST/ (BOX):	$	0.40
TOTAL DRIVER COST:	$	435	AVERAGE COST/ ( ):	$	0.00
TOTAL VEHICLE COST:	$	79			

The researchers then used the fully automatic option (Option 0) in RouteAssist which enables the computer to fully route and sequence the stops with no manual inputs. RouteAssist, based on vehicle capacity and distance traveled, developed 15 routes. The summary report for this option (Table 2) shows a vehicle utilization rate of 73 percent. The routes with all stops identified are shown in their entirety in Appendix E.

TABLE 2

SUMMARY REPORT FOR OPTION 0

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

*** ROUTE SUMMARY ***

# STP	MILES TRAV-ELED	VEH TYP	BEGIN RTE DAY	BEGIN RTE TIME	END RTE DAY	END RTE TIME	ROUTE TIMING TOTAL TIME	DRIVE TIME	WAIT TIME	ONDUTY TIME	UTIL. (%) (BOX)	UTIL. (%) ( )	COST TOTAL COST $
3	5	1	2	7:30A	2	9:43A	2:13	0:16	0:00	2:13	73	0	35
5	7	1	2	7:30A	2	10:37A	3:07	0:22	0:00	3:07	96	0	49
1	4	1	2	7:30A	2	9:34A	2:04	0:14	0:00	2:04	83	0	32
7	8	1	2	7:30A	2	10:49A	3:19	0:24	0:00	3:19	88	0	53
3	18	1	2	7:30A	2	10:36A	3:06	1:00	0:00	3:06	80	0	60
3	4	1	2	7:30A	2	10:06A	2:36	0:12	0:00	2:36	95	0	39
4	5	1	2	7:30A	2	9:46A	2:16	0:15	0:00	2:16	68	0	36
3	4	1	2	7:30A	2	9:46A	2:16	0:12	0:00	2:16	78	0	35
1	2	1	2	7:30A	2	8:58A	1:28	0:06	0:00	1:28	60	0	22
2	7	1	2	7:30A	2	9:38A	2:08	0:23	0:00	2:08	71	0	36
1	4	1	2	7:30A	2	9:03A	1:33	0:14	0:00	1:33	58	0	25
1	4	1	2	7:30A	2	8:54A	1:24	0:14	0:00	1:24	50	0	23
1	4	1	2	7:30A	2	9:14A	1:44	0:14	0:00	1:44	67	0	27
1	2	1	2	7:30A	2	8:51A	1:21	0:06	0:00	1:21	54	0	20
1	4	1	2	7:30A	2	9:18A	1:48	0:14	0:00	1:48	70	0	28
37							32:23		0:00		D 73	0	520
	82							4:26		32:23	P 0	0	

*** SUMMARY STATISTICS FOR PRIVATE FLEET ***

TOTAL NUMBER OF ROUTES:	15	AVERAGE MILES/ROUTE:	5
TOTAL NUMBER OF LUNCHES:	0	AVERAGE STOPS/ROUTE:	2
TOTAL NUMBER OF LAYOVERS:	0	AVERAGE COST/ROUTE:	$ 35
TOTAL DEMAND SHIPPED: (BOX)	1307	AVERAGE COST/MILE:	$ 6.34
TOTAL DEMAND SHIPPED: ( )	0	AVERAGE COST/STOP:	$ 14
TOTAL NUMBER OF LOADED MILES:	60	AVERAGE COST/ (BOX):	$ 0.40
TOTAL DRIVER COST:	$ 438	AVERAGE COST/ ( ):	$ 0.00
TOTAL VEHICLE COST:	$ 82		

The researchers then tried a combination approach option (option 3) in RouteAssist. This option was chosen as it lets the dispatcher assign some stops to routes and the computer will then assign the rest of the stops to routes and resequence the stops to minimize costs. This option produced 13 routes with a vehicle utilization rate of 84 percent (Table 3). The routes with the stops identified for this option are shown in their entirety in Appendix F.

TABLE 3

SUMMARY REPORT FOR OPTION 3

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

*** ROUTE SUMMARY ***

# STP	MILES TRAV-ELED	VEH TYP	BEGIN RTE DAY	BEGIN RTE TIME	END RTE DAY	END RTE TIME	TOTAL TIME	DRIVE TIME	WAIT TIME	ONDUTY TIME	UTIL. (%) (BOX	UTIL. (%) ( )	COST TOTAL COST $
7	8	1	2	7:30A	2	10:51A	3:21	0:24	0:00	3:21	89	0	53
4	6	1	2	7:30A	2	10:07A	2:37	0:19	0:00	2:37	82	0	41
2	4	1	2	7:30A	2	9:32A	2:02	0:13	0:00	2:02	74	0	31
2	5	1	2	7:30A	2	10:04A	2:34	0:17	0:00	2:34	98	0	40
4	6	1	2	7:30A	2	10:28A	2:58	0:19	0:00	2:58	99	0	46
1	4	1	2	7:30A	2	9:18A	1:48	0:14	0:00	1:48	70	0	28
2	3	1	2	7:30A	2	9:57A	2:27	0:09	0:00	2:27	98	0	36
2	15	1	2	7:30A	2	10:04A	2:34	0:49	0:00	2:34	71	0	50
6	7	1	2	7:30A	2	10:42A	3:12	0:21	0:00	3:12	93	0	50
3	5	1	2	7:30A	2	10:14A	2:44	0:16	0:00	2:44	98	0	42
2	3	1	2	7:30A	2	9:58A	2:28	0:09	0:00	2:28	99	0	36
1	2	1	2	7:30A	2	8:58A	1:28	0:06	0:00	1:28	60	0	22
1	6	1	2	7:30A	2	9:10A	1:40	0:20	0:00	1:40	58	0	29
37							31:53		0:00		D 84	0	505
	74							3:56		31:53	P 0	0	

*** SUMMARY STATISTICS FOR PRIVATE FLEET ***

TOTAL NUMBER OF ROUTES:	13	AVERAGE MILES/ROUTE:		6
TOTAL NUMBER OF LUNCHES:	0	AVERAGE STOPS/ROUTE:		3
TOTAL NUMBER OF LAYOVERS:	0	AVERAGE COST/ROUTE:	$	39
TOTAL DEMAND SHIPPED: (BOX)	1307	AVERAGE COST/MILE:	$	6.83
TOTAL DEMAND SHIPPED: ( )	0	AVERAGE COST/STOP:	$	14
TOTAL NUMBER OF LOADED MILES:	56	AVERAGE COST/ (BOX):	$	0.39
TOTAL DRIVER COST:	$ 431	AVERAGE COST/ ( ):	$	0.00
TOTAL VEHICLE COST:	$ 74			

The researchers compared the vehicle utilization rates between the routes developed by MHRB and the routes developed by RouteAssist. The results (based upon the summary reports) are as follows:

MHRB developed routes	84%
RouteAssist Option 0 (fully automatic)	73%
RouteAssist Option 3 (combination)	84%.

V. Conclusions and Recommendations

Introduction

This chapter discusses the conclusions the researchers developed after analyzing the information gathered in answering the investigative questions. Each question will be discussed separately. This chapter also discusses recommendations made by the researchers.

Investigative Questions

1. What type of vehicle routing procedure does an Air Force base transportation organization employ? To draw a conclusion on this question, the researchers acquired knowledge from various sources in the Air Force transportation field to include the 645th Transportation Squadron on Wright-Patterson AFB, fellow AFIT transportation students, and senior officers at HQ ACC/LGT, HQ PACAF/LGT, and HQ USAF/LGTV. By using a broad range of resources from base level to headquarter staff, a confident generalization about vehicle routing procedures is established.

The researchers selected the 645th Transportation Squadron for two major reasons. First, it represents a typical base transportation organization in the Air Force. Second, it is conveniently located near the Air Force Institute of Technology.

The researchers conducted a personal interview with the supervisor of dispatch operations to gather information on vehicle routing procedures at this base. He provided the researchers with a copy of AFR 77-310, Vehicle Operations Management and Use of Motor Vehicles, Vol I which provides squadron commanders and transportation supervisors regulatory guidance on the conduct of transportation functions at the base level.

Interviews with fellow AFIT transportation students provided a source of knowledge in transportation operations at base level from various locations worldwide. Although there were minor discrepancies about exact operating procedures at various Air Force bases, each student mutually agreed on vehicle routing methods currently being used in Air Force base transportation organizations.

To establish a stronger degree of validity, the researchers conferred with known transportation experts at HQ ACC/LGT, HQ PACAF/LGT, and HQ USAF/LGTV. These senior officers also confirmed the current practice of vehicle routing in base transportation organizations and added that computerized vehicle routing programs could provide benefits in efficiency and cost savings.

Based on the review of AFR 77-310, personal interviews with the supervisor of dispatch operations and fellow AFIT students, and telephone interviews with officers at HQ ACC/LGT, HQ PACAF/LGT, and HQ USAF/LGTV, the researchers conclude Air Force base transportation organizations use heuristic methods or rules-of-thumb to route vehicles. These methods rely on dispatchers' and drivers' personal knowledge and experience. Although the sophistication of the manual routing procedures may vary from base to base depending on the personnel who work at that location, the researchers also conclude that computerized vehicle routing programs are not being used in Air Force base transportation organizations at this time.

2. Which commercial computerized vehicle routing programs are most compatible with Air Force base transportation organizations? There are numerous types of computerized vehicle routing programs on the market. Some of the programs are designed to meet specific requirements of a particular transportation company while other programs are more generic. To identify which commercial computerized vehicle routing programs are most compatible, the researchers first searched the industry literature to determine the commercial computerized vehicle routing programs currently in use. The researchers contacted Microanalytics Corporation, a leading expert in the field of vehicle routing programs, to acquire a listing of programs currently on the market. They, in turn, shipped the researchers a copy of the 1992 Distribution/Computer EXPO Handbook. This handbook provided an extensive listing of various types of vehicle routing programs.

Next, the researchers developed four criteria that a base transportation officer would use if he were buying a commercial computerized vehicle routing program. First, only select programs that applied to vehicle routing problems in a limited geographical area. Second, operated on IBM compatible systems with at least 30 megabytes of hard drive storage. Third, priced below $20,000. Fourth, had an available training program provided by the manufacturer. Based on these criteria, three computerized vehicle routing programs were identified: Truckstops, TRACS, and RouteAssist.

After comparing the capabilities of each program, the researchers chose to use RouteAssist in this study. This decision was based upon two major reasons. One, RouteAssist allows the researchers to replicate the actual routes used by the Material Handling and Relocations Branch (MHRB) in order to compare routes generated by the program. Neither TRACS nor Truckstops provide this capability. Two, a student version of the program had already been developed for research purposes and was available for this study at no cost.

3. What effect does a commercial computerized vehicle routing program have on vehicle utilization rates in an Air Force base transportation organization? To determine if a commercial computerized vehicle routing program can effectively improve vehicle utilization in an Air Force base transportation organization, the researchers compared actual routing procedures developed by the Material Handling and Relocations Branch (MHRB) located on Wright-Patterson AFB with those developed by RouteAssist. The routing procedures of both MHRB and RouteAssist were used to ascertain vehicle

utilization rates. MHRB represents an Air Force transportation organization that specializes in local area delivery and, due to its location, allowed the researchers to conduct a hands-on analysis.

Personal interviews were conducted with the supervisor of MHRB to determine exactly how he routes the branch's vehicles on a daily basis. MHRB delivers approximately 23 skids of copier paper per month. This equates to 1307 boxes of paper that are delivered to various agencies in Area B on Wright-Patterson AFB. This operation is conducted over a three day period each month. The researchers determined that the branch's monthly delivery of copier paper in Area B should be used in this study as it paralleled the traveling salesman problem.

The researchers compared the current manual routing procedures used by MHRB with routing procedures developed by RouteAssist. Although RouteAssist has eight varying routing options, only option 0 (fully automatic) and option 3 (combination) were used. Option 0 allows the computer to fully assign stops to routes and develop the routes. Option 3 allows the dispatcher to assign some stops to routes and then lets the computer assign the rest of the stops, resequence the stops on a route, and develop the routes. This comparison enabled the researchers to ascertain vehicle utilization rates between the different procedures.

Based upon this comparison, the researchers conclude that, in this study, RouteAssist did not improve vehicle utilization rates. Option 3 (combination) resulted in the same vehicle utilization rate as the manual routing procedure. Option 0 (fully automatic) resulted in a lower vehicle utilization rate than the other two procedures.

The results of the comparison were not consistent with the results of the case studies identified in the literature research. These case studies reported increased vehicle utilization rates when computerized vehicle routing programs were implemented in various types of vehicle routing problems. The inconsistent results in this study may have been brought about by the limited distances involved in Area B. Additionally, the number of stops per route in this study may have affected the results. The researchers contacted Amy Ilyes, a project manager with Leaseway Technology Corp., who confirmed this line of reasoning. She said a study involving greater distances with more stops on each route may improve vehicle utilization (20).

Recommendations

The military should not discount the use of computerized vehicle routing programs based on the outcome of this study alone. There are several options open to further studies based on the literature search and interviews with vehicle routing experts.

First, RouteAssist is used in this study because it allows the researchers to replicate the routes and stops that MHRB currently uses to compare with routes developed by

RouteAssist and Leaseway Technology has a student version available for universities to use in research. Truckstops, another program referenced in this study, can also be used for analysis. This program essentially provides the same services as RouteAssist but also utilizes a geographical database (map) that stores everything from local, intra-city routes on-up-to large regional or national delivery operations. These highly flexible landmark data files allows the researchers to tailor maps to specific needs. A variety of road maps are available from detailed street maps for local delivery to more general maps for over the road routing. In addition, Truckstops allows the user to input exact distances between stops without rounding to a whole number as in the case of RouteAssist and other programs.

However, there are some obstacles to overcome if Truckstops is to be used in a future study. First, Truckstops is not currently available in a student version format as is RouteAssist. Researchers would have to coordinate with Microanalytics Corp. in Arlington, Virginia to use the program for research purposes. Second, Truckstops does not allow the user to replicate a heuristic routing procedure that is found in an Air Force base transportation organization. Thus, the program would have to be modified to include a detailed street map of the area being studied. Although Truckstops provides detailed civilian street maps, a military installation map is not in Truckstops geographical database. This map would need to be created and input into the program before any study could be conducted for military operations.

Second, this study primarily focuses on vehicle utilization rates. There are other aspects of cost savings such as total driver cost, total vehicle cost, average cost/route, and average cost/mile that may be explored in future research. RouteAssist provides statistics for each of these categories (see Tables 1, 2, 3 and Appendices D, E, F). It is interesting to note that Option 3, a combination option approach, which lets the dispatcher assign some stops to routes and then allows the computer to assign the rest of the stops to routes, reduces original route cost in every category except average cost/mile. Although the reductions are minor, there are cost savings realized using RouteAssist.

Third, the researchers recommend a simulation model utilizing the traveling salesman problem algorithms be developed specifically for local area delivery operations involving short distances. This simulation model could be developed in conjunction with one of the companies currently developing vehicle routing programs, i.e., Leaseway Technology or Microanalytics Corp., or with the Air Force Logistics Management Center located at Gunter AFB, Alabama. After a model is developed, a study similar to this study should be conducted to determine the effect on vehicle utilization rates.

Fourth, a similar study to this one could be conducted using operations involving greater distances and more stops per route. Specifically, the researchers suggest using the military mail delivery operation in Germany currently conducted by the 37th Transportation Command, U.S. Army. This operation delivers mail from Rhein-Mein AB to every military installation in Germany covering hundreds of miles and over 50 stops. Another possibility might be the cargo movement operations for Team Spirit exercises in Korea currently conducted by 7th Air Force. This operation delivers incoming cargo from Osan AB throughout the Republic of Korea. Again, the routes would involve hundreds of miles with multiple stops. These operations may be of significant scale to have different results.

Finally, a study involving the applicability of computerized vehicle routing programs in the military during contingencies could be researched. The recent Desert Storm conflict may provide valuable information regarding vehicle routing procedures. The transportation operation for this conflict involved a limited number of lengthy main supply routes (MSR) with multiple stops utilizing a set number of vehicles. This study would apply to both Air Force and Army transportation operations.

ROUTEASSIST DATA COLLECTION FORM

Company Name: 645 TRANS / LGTTB

Contact Name, title, phone number: E.K. KARAMBELAS / Supervisor, Material Handling Branch (513) 255 - 5530

Dispatch Scenario:

3 ~~Single~~ man operation
___ Sleeper team operation
___ Combination of both ________ # of team drivers ________ # of single drivers

Intrazip mileage: ____ (0-10 miles) (Default distance between stops, if two consecutive stops share the same zipcode)

Is common carrier analysis desired: NO (yes/no)

Is fleet sizing analysis desired: NO (yes/no)

Layover policy parameters (for single man scenario only)

Maximum driving time before layover:	NA	(10 hrs)	(DOT default)
Maximum on-duty time before layover:	NA	(15 hrs)	(DOT default)
Duration of layover:	NA	(8 hrs)	(DOT default)
Maximum duration of non-compensated layover:	NA	(14 hrs)	(DOT default)

Layover cost: $ NA (per layover)

Driver costing scenarios: Check one of the following:

✓ Local routes only.

___ Over-the-road routes only.

___ Both local and over-the-road routes are possible.

Are drivers paid for waiting time at the stops: NO (yes/no) (Not applicable for local routes)
Are drivers paid on any incentive basis: NO (yes/no) (e.g. $/stop, $/unit unloaded, etc...)

Incentive rate: $________

Local routes driver costing:

Driver cost per hour for straight time: $ 13.52 ($/hour) 3 mos average

Driver cost per hour for over time: $ 20.28 ($/hour) average may thru nov

Time on duty before over time begins: NA (hours)

Distance up to which a route is considered a local route: 10 (miles) or less

Please specify if the above mileage figure is: NA (Based on one-way route mileage)
NA (Based on total route mileage)

Single man over-the-road costing:

Mileage and hourly costs: *(Driver gets paid based on mileage cost for driving and hourly, straight time, pay for loading and unloading time)*

Hourly cost for loading and unloading: $ NA ____ ($/hour)

Mileage cost: $ NA ____ ($/mile)

Sleeper team costing:

Mileage and hourly costs: *(Drivers get paid based on mileage cost for driving and hourly, straight time, pay for loading and unloading time)*

Hourly cost for loading and unloading: $ NA ____ ($/hour) (Each driver gets paid this amount for loading and unloading time)

Mileage cost: $ NA ____ ($/mile) (Both drivers share this $/mile rate, i.e. they each receive half this amount)

Lunch break parameters: *(Single man scenario only)*

Minimum on-duty time before lunch break: ✓ ____ (4 hrs) (DOT default)
Maximum on-duty time before lunch break: ____ (6 hrs) (DOT default)
Duration of lunch break: ✓ ____ (1 hrs) (DOT default)

Break parameters: *(Sleeper team scenario only)*

On-duty time before break: ____ (4 hrs) (DOT default)
Duration of break: ____ (30 min) (DOT default)

Vehicle speed parameters: *(Figures within parentheses are default values)*

From:	Mileage Band: To:	
____ (0 miles)	____ (5 miles)..........	____ (18mph)
____ (6 miles)	____ (30 miles).........	____ (35mph)
____ (31 miles)	____ (99999 miles)......	____ (50mph)

Vehicle information:

Total cost of operating fleet: $________ (per mile)

Vehicle ID	Description of Vehicle	No. of vehicles available	Maximum no. of stops vehicle may serve	Maximum distance vehicle may travel (mile)	Maximum time vehicle may travel (hr:min)	Earliest vehicle departure time	Vehicle fixed cost per week	Vehicle cost per mile	Vehicle capacity measured in unit #1	Vehicle capacity measured in unit #2
	TON + HALF CARGO	3	42	10	4 HRS	0730				

Notes: Please list the vehicles in increasing order of capacity.
Vehicle ID field should be numeric (1-19) and should be in increasing order.
There is a maximum of 19 different types of vehicles allowed.
This page should be copied in order to list all vehicle types.

Fleet sizing:

Planning horizon, or period within which all routing activity must take place: ____________
(e.g. Sunday through Saturday)

Normal delivery days for all stops: ____________
(e.g. Monday through Friday)

Any restriction on starting day of route: ____________

Depot is open for loading and unloading between what hours: ____________

Depot is open for loading and unloading between what days: ____________
(e.g. Monday through Friday)

Minimum elapsed time between trips for a tractor: ____________

Minimum elapsed time between trips for a driver: ____________

Hook time for a trailer: ____________

Drop time for a trailer: ____________

Time to reload a trailer at the depot: ____________

Latest time a trailer may arrive at depot and still be loaded: ____________

Depot information:

Depot city name: ______

State: ______

Zip: ______

All stops are:

Pickup: ______
Delivery: ✓
Backhaul: (pickup and delivery) ______ What percentage of backhauls return to depot: ______ %

First unit of measure (demand) for all stops is (e.g. pounds, pallets, cube, etc.) 52 POUNDS

Second unit of measure (demand) for all stops is (e.g. pounds, pallets, cube, etc.) N/A PALLETS

Type of commodity being shipped: COPIER PAPER

Unloading time for all stops:

Each stop is different and unloading time will be entered for each stop: YES (yes/no)

Each stop is the same and only one unloading time will be used for all stops: NO (yes/no)

Unloading time(constant) for each stop: NO

Each stop's unloading time may be approximated by using a fixed and variable time element. The variable rate is applied to the demand for the first unit of measure only. (For example 10 minutes fixed for paper work at each stop and 1 minute per each unit of measure to be unloaded. If a stop had 20 units to unload the unloading time would be 10 minutes fixed plus 20 minutes variable or 30 minutes total) ______ (yes/no)

Unloading time for each stop: Fixed: N/A (minutes)

Variable: ______

Window times for all stops: ______
(Different time windows for individual stops may be used if noted in the stop information file)

Stop information: Should include all private fleet activity (including backhauls) and any common carriage activity plus cost. Backhaul revenue should be entered as the common carriage cost. If a backhaul point must be served by the private fleet, then a zero common carriage cost should be entered.

Customer ID	City	State	Zipcode	Demand in unit #1	Demand in unit #2	Pickup -P! Delivery-D	Unloading time	Time window, if different than standard	Common carriage cost if applicable	Largest veh. ID which can service stop

This page should be copied in order to list all stops. Data on tape or diskette is preferable, see format on next page.

Appendix B: Stop Data

Stop #	Building #	Demand in Boxes
1	1	27
2	6	5
3	8	10
4	11	69
5	11A	60
6	12	80
7	125	65
8	126	15
9	14	84
10	15	57
11	156	3
12	16	77
13	16	100
14	16	12
15	167	2
16	17	16
17	190	8
18	192	13
19	193	20
20	20	16
21	2041	20
22	2042	20
23	22	11
24	274 (Area A)	20
25	28	70
26	39	6
27	46	49
28	485	10
29	50	55
30	50A	15
31	52	55
32	55	1
33	56	63
34	57	72
35	676	30
36	91	1
37	C-17	70

Appendix C: Distance Matrix

STOPS

DEP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
DEP	1	2	1	1	2	2	1	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	7	1	2	1	2	1	1	1	1	1	1	1	1	3
1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	9	1	1	1	1	1	1	1	1	1	1	1	1	4
2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
3				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
4					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
5						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
6							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
7								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	1	1	1	1	1	1	1	1	1	1	1	1	3
8									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	1	1	1	1	1	1	1	1	1	1	1	1	3
9										1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
10											1	1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
11												1	1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	2	2	1	4
12													1	1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
13														1	1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
14															1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
15																1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
16																	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
17																		1	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
18																			1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
19																				1	1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
20																					1	1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
21																						1	1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
22																							1	8	1	1	1	1	1	1	1	1	1	1	1	1	4
23																								8	1	1	1	1	1	1	1	1	1	1	1	1	4
24																									8	8	8	8	8	8	8	8	8	8	7	8	10
25																										1	1	1	1	1	1	1	1	1	1	1	4
26																											1	1	1	1	1	1	1	1	1	1	4
27																												1	1	1	1	1	1	1	1	1	4
28																													1	1	1	1	1	1	1	1	4
29																														1	1	1	1	1	1	1	4
30																															1	1	1	1	1	1	4
31																																1	1	1	1	1	4
32																																	1	1	1	1	4
33																																		1	1	1	4
34																																			1	1	4
35																																				1	3
36																																					4
37																																					

STOPS

Note: All distances are in miles.

Appendix D: Original Routes

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:01 AM

ROUTE # 1 (NAME: 1)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK
CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
29	STOP35	WPAFB	OH	2	7:33A	0:00	30	0	D	40	0:03	1
36	STOP8	WPAFB	OH	2	8:16A	0:00	15	0	D	25	0:03	1
7	STOP15	WPAFB	OH	2	8:44A	0:00	2	0	D	12	0:03	1
35	STOP7	WPAFB	OH	2	8:59A	0:00	65	0	D	75	0:03	1
3	STOP11	WPAFB	OH	2	10:17A	0:00	3	0	D	13	0:03	1
12	STOP2	WPAFB	OH	2	10:33A	0:00	5	0	D	15	0:03	1
	BACK TO DEPOT			2	10:55A						0:07	2
	TOTALS					0:00	120	0	D	180	0:25	8
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---

ON DUTY HOURS:	
DRIVING	0:25
WAITING	0:00
UNLOAD	3:00
	3:25
OFF DUTY HOURS:	
LUNCH	0:00
LAYOVER(0)	0:00
	0:00
TOTAL TIME	3:25

---------- ROUTE COSTING ----------

DRIVER COST:	
HOURLY @ $ 13.52/HR.X2	46.19
OVERTIM @ $ 20.28/HOUR	0.00
LAYOVER @ $ 50.00/LAY	0.00
	46.19
VEHICLE COST:	
FIXED	0.00
MILEAGE @ $1.0000/MILE	8.00
	8.00
DROP COST: @ $ 0.00/STOP	0.00
TOTAL ROUTE COST	54.19

----- VEH DETAILS -----

	(BOX) (	)
VEH.CAP.	120	120
DELIVER	120	0
PICKUP	0	0
VEHICLE UTILIZATION (%)		
DELIVER	100	0
PICKUP	0	0
AVERAGE SPEED (MPH)	19	

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

ROUTE # 2 (NAME: 10)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---			L\U	PREV STOP DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))		TIM MIN	TIME HR:MN	DIST MILE
27	STOP33	WPAFB	OH	2	7:33A	0:00	63	0	D	73	0:03	1
	BACK TO DEPOT			2	8:49A						0:03	1
	TOTALS					0:00	63 0	0 0	D P	73	0:06	2

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:06	HOURLY @ $ 13.52/HR.X2	17.80	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:13	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	63	0
	------		------	PICKUP	0	0
	1:19		17.80			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	2.00	DELIVER	52	0
	------		------	PICKUP	0	0
	0:00		2.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)		20
TOTAL TIME	1:19	TOTAL ROUTE COST	19.80			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:01 AM

ROUTE # 3 (NAME: 11)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/--- PICKUP (BOX)		L\U TIM MIN	PREV STOP DRV. TIME HR:MN	DIST MILE
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	(	)			
28	STOP34	WPAFB	OH	2	7:33A	0:00	72	0 D	82	0:03	1
	BACK TO DEPOT			2	8:58A					0:03	1
	TOTALS					0:00	72	0 D	82	0:06	2
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:06	HOURLY @ $ 13.52/HR.X2	19.83	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:22	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	72	0
	------		-------	PICKUP	0	0
	1:28		19.83			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	2.00	DELIVER	60	0
	------		-------	PICKUP	0	0
	0:00		2.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)	20	
TOTAL TIME	1:28	TOTAL ROUTE COST	21.83			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

ROUTE # 4 (NAME: 12)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
4	STOP12	WPAFB	OH	2	7:37A	0:00	77	0	D	87	0:07	2
	BACK TO DEPOT			2	9:11A						0:07	2
	TOTALS					0:00	77	0	D	87	0:14	4
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)		
ON DUTY HOURS:		DRIVER COST:			(	)
DRIVING	0:14	HOURLY @ $ 13.52/HR.X2	22.76	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:27	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	77	0
	-------		-------	PICKUP	0	0
	1:41		22.76			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	64	0
	-------		-------	PICKUP	0	0
	0:00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	-------		---------	AVERAGE SPEED (MPH)		17
TOTAL TIME	1:41	TOTAL ROUTE COST	26.76			

```
LEASEWAY TECHNOLOGY CORP.                                   ROUTEASSIST 08/03/93
                                                                      11:01 AM
                              ROUTE #   5 (NAME:  13     )

                                  *** SCHEDULE ***

   A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB   ,OH  WITH TRUCK
   CATEGORY  1 (1 1/2 TON ) AT   7:30 AM, DAY  2.

     ARRIVE AT STOPS                                                    PREV STOP
-----------------------------------------        ---DELIVERY/---  L\U  DRV.
NO. ID          CITY          ST DAY TIME   WAIT    PICKUP           TIM  TIME   DIST
                                            HR:MN  (BOX      )       MIN  HR:MN  MILE
                                                      (          )
  5 STOP13      WPAFB         OH  2  7:37A  0:00    100         0 D  110   0:07     2
   BACK TO DEPOT                  2  9:34A                                  0:07     2
                                            -----  ------ ------     ---- ------ -----
   TOTALS                                   0:00    100         0 D  110   0:14     4
                                                      0         0 P

        (#) : THESE DISTANCES CALCULATED BY ROUTEASSIST


                                  *** ANALYSIS ***

--- ROUTE TIMING --- --------- ROUTE COSTING ---------- ----- VEH DETAILS -----
                                                             (BOX      )
ON DUTY HOURS:       DRIVER COST:                                  (            )
 DRIVING      0:14    HOURLY  @ $ 13.52/HR.X2  27.94     VEH.CAP.     120         120
 WAITING      0:00    OVERTIM @ $ 20.28/HOUR    0.00
 UNLOAD       1:50    LAYOVER @ $ 50.00/LAY     0.00      DELIVER     100           0
             ------                           ------      PICKUP        0           0
               2:04                            27.94

OFF DUTY HOURS:      VEHICLE COST:                       VEHICLE UTILIZATION (%)
 LUNCH        0:00    FIXED                     0.00
 LAYOVER( 0)  0:00    MILEAGE @ $1.0000/MILE    4.00      DELIVER      83           0
             ------                           ------      PICKUP        0           0
               0:00                              4.00
                     DROP COST: @ $   0.00/STOP   0.00
             ------                          -------- AVERAGE SPEED (MPH)   17
TOTAL TIME     2:04 TOTAL ROUTE COST          31.94
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LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:01 AM

ROUTE # 6 (NAME: 2)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK
CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV DRV.	STOP
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)	TIM MIN	TIME HR:MN	DIST MILE
16	STOP23	WPAFB	OH	2	7:33A	0:00	11	0 D	21	0:03	1
23	STOP3	WPAFB	OH	2	7:57A	0:00	10	0 D	20	0:03	1
21	STOP28	WPAFB OH	OH	2	8:20A	0:00	10	0 D	20	0:03	1
13	STOP20	WPAFB	OH	2	8:43A	0:00	16	0 D	26	0:03	1
19	STOP26	WPAFB	OH	2	9:12A	0:00	6	0 D	16	0:03	1
30	STOP36	WPAFB	OH	2	9:31A	0:00	1	0 D	11	0:03	1
26	STOP32	WPAFB	OH	2	9:45A	0:00	1	0 D	11	0:03	1
20	STOP27	WPAFB	OH	2	9:59A	0:00	49	0 D	59	0:03	1
	BACK TO DEPOT			2	11:01A					0:03	1
	TOTALS					0:00	104	0 D	184	0:27	9
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX) (	)
ON DUTY HOURS:		DRIVER COST:			
DRIVING	0:27	HOURLY @ $ 13.52/HR.X2	47.55	VEH.CAP. 120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00		
UNLOAD	3:04	LAYOVER @ $ 50.00/LAY	0.00	DELIVER 104	0
	-------		--------	PICKUP 0	0
	3:31		47.55		
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)	
LUNCH	0:00	FIXED	0.00		
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	9.00	DELIVER 87	0
	------		--------	PICKUP 0	0
	0:00		9.00		
		DROP COST: @ $ 0.00/STOP	0.00		
	------		--------	AVERAGE SPEED (MPH)	20
TOT' IME	3:31	TOTAL ROUTE COST	56.55		

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

ROUTE # 7 (NAME: 3)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/--- PICKUP (BOX)		L\U	PREV STOP DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	(	)	TIM MIN	TIME HR:MN	DIST MILE
32	STOP4	WPAFB	OH	2	7:37A	0:00	69	0 D	79	0:07	2
9	STOP17	WPAFB	OH	2	8:59A	0:00	8	0 D	18	0:03	1
10	STOP18	WPAFB	OH	2	9:20A	0:00	13	0 D	23	0:03	1
11	STOP19	WPAFB	OH	2	9:46A	0:00	20	0 D	30	0:03	1
	BACK TO DEPOT			2	10:19A					0:03	1
	TOTALS					0:00	110	0 D	150	0:19	6
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:19	HOURLY @ $ 13.52/HR.X2	38.08	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:30	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	110	0
	------		-------	PICKUP	0	0
	2:49		38.08			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	6.00	DELIVER	92	0
	------		-------	PICKUP	0	0
	0:00		6.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)	19	
TOTAL TIME	2:49	TOTAL ROUTE COST	44.08			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:01 AM

ROUTE # 8 (NAME: 4)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK
CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS						---DELIVERY/---		L\U	PREV STOP	
									DRV.	
NO. ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))	TIM MIN	TIME HR:MN	DIST MILE
33 STOP5	WPAFB	OH	2	7:37A	0:00	60	0 D	70	0:07	2
2 STOP10	WPAFB	OH	2	8:50A	0:00	57	0 D	67	0:03	1
BACK TO DEPOT			2	10:04A					0:07	2
TOTALS					0:00	117	0 D	137	0:17	5
						0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS -----		
					(BOX (	))
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:17	HOURLY @ $ 13.52/HR.X2	34.70	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:17	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	117	0
				PICKUP	0	0
	2:34		34.70			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	5.00	DELIVER	98	0
				PICKUP	0	0
	0:00		5.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	18	
TOTAL TIME	2:34	TOTAL ROUTE COST	39.70			

ROUTE # 9 (NAME: 5)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))	TIM MIN	DRV. TIME HR:MN	DIST MILE
34	STOP6	WPAFB	OH	2	7:37A	0:00	80	0 D	90	0:07	2
1	STOP1	WPAFB	OH	2	9:10A	0:00	27	0 D	37	0:03	1
6	STOP14	WPAFB	OH	2	9:50A	0:00	12	0 D	22	0:03	1
	BACK TO DEPOT			2	10:19A					0:07	2
	TOTALS					0:00	119	0 D	149	0:20	6
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:20	HOURLY @ $ 13.52/HR.X2	38.08	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:29	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	119	0
				PICKUP	0	0
	2:49		38.08			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	6.00	DELIVER	99	0
				PICKUP	0	0
	0:00		6.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	18	
TOTAL TIME	2:49	TOTAL ROUTE COST	44.08			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

ROUTE # 10 (NAME: 6)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))	TIM MIN	DRV. TIME HR:MN	DIST MILE
37	STOP9	WPAFB	OH	2	7:37A	0:00	84	0 D	94	0:07	2
8	STOP16	WPAFB	OH	2	9:14A	0:00	16	0 D	26	0:03	1
14	STOP21	WPAFB	OH	2	9:43A	0:00	20	0 D	30	0:03	1
	BACK TO DEPOT			2	10:16A					0:03	1
	TOTALS					0:00	120 0	0 D 0 P	150	0:16	5

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:16	HOURLY @ $ 13.52/HR.X2	37.41	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:30	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	120	0
	------		-------	PICKUP	0	0
	2:46		37.41			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	5.00	DELIVER	100	0
	------		-------	PICKUP	0	0
	0:00		5.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)		19
TOTAL TIME	2:46	TOTAL ROUTE COST	42.41			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

ROUTE # 11 (NAME: 7)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
25	STOP31	WPAFB	OH	2	7:33A	0:00	55	0	D	65	0:03	1
22	STOP29	WPAFB	OH	2	8:41A	0:00	55	0	D	65	0:03	1
	BACK TO DEPOT			2	9:49A						0:03	1
	TOTALS					0:00	110	0	D	130	0:09	3
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		----- VEH DETAILS ----- (BOX)		
ON DUTY HOURS:		DRIVER COST:			(	)
DRIVING	0:09	HOURLY @ $ 13.52/HR.X2	31.32	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:10	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	110	0
				PICKUP	0	0
	2:19		31.32			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	3.00	DELIVER	92	0
				PICKUP	0	0
	0:00		3.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)		20
TOTAL TIME	2:19	TOTAL ROUTE COST	34.32			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

ROUTE # 12 (NAME: 8)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS

NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	---DELIVERY/--- PICKUP (BOX) (	)		L\U TIM MIN	PREV STOP DRV. TIME HR:MN	DIST MILE
18	STOP25	WPAFB	OH	2	7:33A	0:00	70	0	D	80	0:03	1
17	STOP24	WPAFB	OH	2	9:20A	0:00	20	0	D	30	0:27	8
	BACK TO DEPOT			2	10:13A						0:23	7
	TOTALS					0:00	90	0	D	110	0:53	16
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------			----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:					
DRIVING	0:53	HOURLY @ $ 13.52/HR.X2	36.73		VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00				
UNLOAD	1:50	LAYOVER @ $ 50.00/LAY	0.00		DELIVER	90	0
					PICKUP	0	0
	2:43			36.73			
OFF DUTY HOURS:		VEHICLE COST:			VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00				
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	16.00		DELIVER	75	0
					PICKUP	0	0
	0:00			16.00			
		DROP COST: @ $ 0.00/STOP		0.00			
					AVERAGE SPEED (MPH)		18
TOTAL TIME	2:43	TOTAL ROUTE COST		52.73			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:01 AM

ROUTE # 13 (NAME: 9)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/--- PICKUP		L\U	PREV STOP DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	(BOX) (	)	TIM MIN	TIME HR:MN	DIST MILE
31	STOP37	WPAFB	OH	2	7:40A	0:00	70	0 D	80	0:10	3
24	STOP30	WPAFB	OH	2	9:13A	0:00	15	0 D	25	0:13	4
15	STOP22	WPAFB	OH	2	9:41A	0:00	20	0 D	30	0:03	1
	BACK TO DEPOT			2	10:14A					0:03	1
	TOTALS					0:00	105	0 D	135	0:29	9
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS -----		
					(BOX)	
ON DUTY HOURS:		DRIVER COST:			(	)
DRIVING	0:29	HOURLY @ $ 13.52/HR.X2	36.95	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:15	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	105	0
				PICKUP	0	0
	2:44		36.95			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	9.00	DELIVER	88	0
				PICKUP	0	0
	0:00		9.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)		19
TOTAL TIME	2:44	TOTAL ROUTE COST	45.95			

Appendix E: Option 0 Routes

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 1 (NAME: R0001)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---			L\U	PREV DRV.	STOP
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))		TIM MIN	TIME HR:MN	DIST MILE
1	STOP1	WPAFB	OH	2	7:33A	0:00	27	0	D	37	0:03	1
2	STOP10	WPAFB	OH	2	8:13A	0:00	57	0	D	67	0:03	1
3	STOP11	WPAFB	OH	2	9:23A	0:00	3	0	D	13	0:03	1
	BACK TO DEPOT			2	9:43A						0:07	2
	TOTALS					0:00	87	0	D	117	0:16	5
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

---- ROUTE TIMING ----		---------- ROUTE COSTING ----------		------ VEH DETAILS ------ (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:16	HOURLY @ $ 13.52/HR.X2	29.97	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:57	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	87	0
				PICKUP	0	0
	2:13		29.97			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	5.00	DELIVER	73	0
				PICKUP	0	0
	0:00		5.00			
		DROP COST: @ $ 0.00/STOP	0.00	AVERAGE SPEED (MPH)		19
TOTAL TIME	2:13	TOTAL ROUTE COST	34.97			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 2 (NAME: R0002)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---			L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	)		TIM MIN	DRV. TIME HR:MN	DIST MILE
4	STOP12	WPAFB	OH	2	7:37A	0:00	77	0	D	87	0:07	2
6	STOP14	WPAFB	OH	2	9:07A	0:00	12	0	D	22	0:03	1
7	STOP15	WPAFB	OH	2	9:32A	0:00	2	0	D	12	0:03	1
8	STOP16	WPAFB	OH	2	9:47A	0:00	16	0	D	26	0:03	1
9	STOP17	WPAFB	OH	2	10:16A	0:00	8	0	D	18	0:03	1
	BACK TO DEPOT			2	10:37A						0:03	1
	TOTALS					0:00	115	0	D	165	0:22	7
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		----- VEH DETAILS (BOX (	) -----
ON DUTY HOURS:		DRIVER COST:			
DRIVING	0:22	HOURLY @ $ 13.52/HR.X2	42.14	VEH.CAP. 120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00		
UNLOAD	2:45	LAYOVER @ $ 50.00/LAY	0.00	DELIVER 115	0
				PICKUP 0	0
	3:07		42.14		
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)	
LUNCH	0:00	FIXED	0.00		
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	7.00	DELIVER 96	0
				PICKUP 0	0
	0:00		7.00		
		DROP COST: @ $ 0.00/STOP	0.00	AVERAGE SPEED (MPH)	19
TOTAL TIME	3:07	TOTAL ROUTE COST	49.14		

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:03 AM

ROUTE # 3 (NAME: R0003)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
5	STOP13	WPAFB	OH	2	7:37A	0:00	100	0	D	110	0:07	2
	BACK TO DEPOT			2	9:34A						0:07	2
	TOTALS					0:00	100	0	D	110	0:14	4
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)		
					(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:14	HOURLY @ $ 13.52/HR.X2	27.94	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:50	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	100	0
				PICKUP	0	0
	2:04		27.94			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	83	0
				PICKUP	0	0
	0:00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	17	
TOTAL TIME	2:04	TOTAL ROUTE COST	31.94			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 4 (NAME: R0004)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---			L\U	PREV STOP DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)		TIM MIN	TIME HR:MN	DIST MILE
10	STOP18	WPAFB	OH	2	7:33A	0:00	13	0	D	23	0:03	1
11	STOP19	WPAFB	OH	2	7:59A	0:00	20	0	D	30	0:03	1
12	STOP2	WPAFB	OH	2	8:32A	0:00	5	0	D	15	0:03	1
13	STOP20	WPAFB	OH	2	8:50A	0:00	16	0	D	26	0:03	1
14	STOP21	WPAFB	OH	2	9:19A	0:00	20	0	D	30	0:03	1
15	STOP22	WPAFB	OH	2	9:52A	0:00	20	0	D	30	0:03	1
16	STOP23	WPAFB	OH	2	10:25A	0:00	11	0	D	21	0:03	1
	BACK TO DEPOT			2	10:49A						0:03	1
	TOTALS					0:00	105	0	D	175	0:24	8
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

---- ROUTE TIMING ----		---------- ROUTE COSTING ----------		------ VEH DETAILS ----- (BOX)		
ON DUTY HOURS:		DRIVER COST:			(	)
DRIVING	0:24	HOURLY @ $ 13.52/HR.X2	44.84	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:55	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	105	0
				PICKUP	0	0
	3:19		44.84			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	8.00	DELIVER	88	0
				PICKUP	0	0
	0:00		8.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	20	
TOTAL TIME	3:19	TOTAL ROUTE COST	52.84			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 5 (NAME: R0005)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	DELIVERY/ PICKUP (BOX) (	)		L\U TIM MIN	PREV STOP DRV. TIME HR:MN	DIST MILE
17	STOP24	WPAFB	OH	2	7:53A	0:00	20	0	D	30	0:23	7
18	STOP25	WPAFB	OH	2	8:50A	0:00	70	0	D	80	0:27	8
19	STOP26	WPAFB	OH	2	10:13A	0:00	6	0	D	16	0:03	1
	BACK TO DEPOT			2	10:36A						0:07	2
	TOTALS					0:00	96	0	D	126	1:00	18
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	1:00	HOURLY @ $ 13.52/HR.X2	41.91	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:06	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	96	0
				PICKUP	0	0
	3:06		41.91			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	18.00	DELIVER	80	0
				PICKUP	0	0
	0:00		18.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	18	
TOTAL TIME	3:06	TOTAL ROUTE COST	59.91			

LEASEWAY TECHNOLOGY CORP.

ROUTEASSIST 08/03/93
11:03 AM

ROUTE # 6 (NAME: R0006)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))	TIM MIN	DRV. TIME HR:MN	DIST MILE
20	STOP27	WPAFB	OH	2	7:33A	0:00	49	0 D	59	0:03	1
21	STOP28	WPAFB OH	OH	2	8:35A	0:00	10	0 D	20	0:03	1
22	STOP29	WPAFB	OH	2	8:58A	0:00	55	0 D	65	0:03	1
	BACK TO DEPOT			2	10:06A					0:03	1
	TOTALS					0:00	114 0	0 D 0 P	144	0:12	4

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---

ON DUTY HOURS:	
DRIVING	0:12
WAITING	0:00
UNLOAD	2:24
	2:36
OFF DUTY HOURS:	
LUNCH	0:00
LAYOVER(0)	0:00
	0:00
TOTAL TIME	2:36

--- ROUTE COSTING ---

DRIVER COST:		
HOURLY @ $ 13.52/HR.X2	35.15	
OVERTIM @ $ 20.28/HOUR	0.00	
LAYOVER @ $ 50.00/LAY	0.00	
		35.15
VEHICLE COST:		
FIXED	0.00	
MILEAGE @ $1.0000/MILE	4.00	
		4.00
DROP COST: @ $ 0.00/STOP		0.00
TOTAL ROUTE COST		39.15

--- VEH DETAILS ---

	(BOX (	))
VEH.CAP.	120	120
DELIVER	114	0
PICKUP	0	0
VEHICLE UTILIZATION (%)		
DELIVER	95	0
PICKUP	0	0
AVERAGE SPEED (MPH)	20	

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 7 (NAME: R0007)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV	STOP
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
23	STOP3	WPAFB	OH	2	7:33A	0:00	10	0	D	20	0:03	1
24	STOP30	WPAFB	OH	2	7:56A	0:00	15	0	D	25	0:03	1
25	STOP31	WPAFB	OH	2	8:24A	0:00	55	0	D	65	0:03	1
26	STOP32	WPAFB	OH	2	9:32A	0:00	1	0	D	11	0:03	1
	BACK TO DEPOT			2	9:46A						0:03	1
	TOTALS					0:00	81	0	D	121	0:15	5
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		------ VEH DETAILS ------ (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:15	HOURLY @ $ 13.52/HR.X2	30.65	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:01	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	81	0
				PICKUP	0	0
	2:16		30.65			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	5.00	DELIVER	68	0
				PICKUP	0	0
	0:00		5.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	20	
TOTAL TIME	2:16	TOTAL ROUTE COST	35.65			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 8 (NAME: R0008)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV	STOP
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
27	STOP33	WPAFB	OH	2	7:33A	0:00	63	0	D	73	0:03	1
29	STOP35	WPAFB	OH	2	8:49A	0:00	30	0	D	40	0:03	1
30	STOP36	WPAFB	OH	2	9:32A	0:00	1	0	D	11	0:03	1
	BACK TO DEPOT			2	9:46A						0:03	1
	TOTALS					0:00	94	0	D	124	0:12	4
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		------ VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:12	HOURLY @ $ 13.52/HR.X2	30.65	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:04	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	94	0
				PICKUP	0	0
	2:16		30.65			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	78	0
				PICKUP	0	0
	0:00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	20	
TOTAL TIME	2:16	TOTAL ROUTE COST	34.65			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 9 (NAME: R0009)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---			L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))		TIM MIN	DRV. TIME HR:MN	DIST MILE
28	STOP34	WPAFB	OH	2	7:33A	0:00	72	0	D	82	0:03	1
	BACK TO DEPOT			2	8:58A						0:03	1
	TOTALS					0:00	72	0	D	82	0:06	2
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

ROUTE TIMING		ROUTE COSTING		VEH DETAILS (BOX (		))
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:06	HOURLY @ $ 13.52/HR.X2	19.83	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:22	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	72	0
				PICKUP	0	0
	1:28		19.83			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	2.00	DELIVER	60	0
				PICKUP	0	0
	0:00		2.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)		20
TOTAL TIME	1:28	TOTAL ROUTE COST	21.83			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 10 (NAME: R0010)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---			L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX)	( )		TIM MIN	DRV. TIME HR:MN	DIST MILE
31	STOP37	WPAFB	OH	2	7:40A	0:00	70	0	D	80	0:10	3
36	STOP8	WPAFB	OH	2	9:10A	0:00	15	0	D	25	0:10	3
	BACK TO DEPOT			2	9:38A						0:03	1
	TOTALS					0:00	85	0	D	105	0:23	7
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------			------ VEH DETAILS ------ (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:					
DRIVING	0:23	HOURLY @ $ 13.52/HR.X2	28.84		VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00				
UNLOAD	1:45	LAYOVER @ $ 50.00/LAY	0.00		DELIVER	85	0
					PICKUP	0	0
	2:08			28.84			
OFF DUTY HOURS:		VEHICLE COST:			VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00				
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	7.00		DELIVER	71	0
					PICKUP	0	0
	0:00			7.00			
		DROP COST: @ $ 0.00/STOP		0.00			
					AVERAGE SPEED (MPH)	18	
TOTAL TIME	2:08	TOTAL ROUTE COST		35.84			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:03 AM

ROUTE # 11 (NAME: R0011)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV DRV.	STOP
NO. ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX)	(	)	TIM MIN	TIME HR:MN	DIST MILE
32 STOP4	WPAFB	OH	2	7:37A	0:00	69		0 D	79	0:07	2
BACK TO DEPOT			2	9:03A						0:07	2
TOTALS					0:00	69		0 D	79	0:14	4
						0		0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		----- VEH DETAILS (BOX) -----	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:14	HOURLY @ $ 13.52/HR.X2	20.96	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:19	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	69	0
				PICKUP	0	0
	1:33		20.96			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	58	0
				PICKUP	0	0
	0:00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	17	
TOTAL TIME	1:33	TOTAL ROUTE COST	24.96			

ROUTE # 12 (NAME: R0012)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS						---DELIVERY/---				PREV DRV.	STOP
NO. ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	)		L\U TIM MIN	TIME HR:MN	DIST MILE
33 STOP5	WPAFB	OH	2	7:37A	0:00	60	0	D	70	0:07	2
BACK TO DEPOT			2	8:54A						0:07	2
TOTALS					0:00	60	0	D	70	0:14	4
						0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		------ VEH DETAILS ------ (BOX	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:14	HOURLY @ $ 13.52/HR.X2	18.93	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:10	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	60	0
				PICKUP	0	0
	1:24		18.93			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	50	0
				PICKUP	0	0
	0:00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00	AVERAGE SPEED (MPH)		17
TOTAL TIME	1:24	TOTAL ROUTE COST	22.93			

ROUTE # 13 (NAME: R0013)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK
CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV STOP	
NO	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
34	STOP6	WPAFB	OH	2	7:37A	0:00	80	0	D	90	0:07	2
	BACK TO DEPOT			2	9:14A						0:07	2
	TOTALS					0:00	80	0	D	90	0:14	4
							0	0	P			

(#) THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)		
ON DUTY HOURS		DRIVER COST:			(	)
DRIVING	0 14	HOURLY @ $ 13.52/HR.X2	23.43	VEH.CAP.	120	120
WAITING	0 00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1 30	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	80	0
	------		--------	PICKUP	0	0
	1.44		23.43			
OFF DUTY HOURS		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0 00	FIXED	0.00			
LAYOVER (0)	0 00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	67	0
	------		--------	PICKUP	0	0
	0 00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)	17	
TOTAL TIME	1 44	TOTAL ROUTE COST	27.43			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:03 AM

ROUTE # 14 (NAME: R0014)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS						---DELIVERY/---			L\U	PREV DRV.	STOP
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))		TIM MIN	TIME HR:MN	DIST MILE
35	STOP7	WPAFB	OH	2	7:33A	0:00	65	0	D	75	0:03	1
	BACK TO DEPOT			2	8:51A						0:03	1
	TOTALS					0:00	65	0	D	75	0:06	2
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--- ROUTE COSTING ---		--- VEH DETAILS --- (BOX (	))
ON DUTY HOURS:		DRIVER COST:			
DRIVING	0:06	HOURLY @ $ 13.52/HR.X2	18.25	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:15	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	65	0
				PICKUP	0	0
	1:21		18.25			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	2.00	DELIVER	54	0
				PICKUP	0	0
	0:00		2.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)	20	
TOTAL TIME	1:21	TOTAL ROUTE COST	20.25			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:03 AM

ROUTE # 15 (NAME: R0015)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MM	PICKUP (BOX (	))	TIM MIN	DRV. TIME HR:MN	DIST MILE
37	STOP9	WPAFB	OH	2	7:37A	0:00	84	0 D	94	0:07	2
	BACK TO DEPOT			2	9:18A					0:07	2
	TOTALS					0:00	84	0 D	94	0:14	4
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:14	HOURLY @ $ 13.52/HR.X2	24.34	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:34	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	84	0
				PICKUP	0	0
	1:48		24.34			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	70	0
				PICKUP	0	0
	0:00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)		17
TOTAL TIME	1:48	TOTAL ROUTE COST	28.34			

Appendix F: Option 3 Routes

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

ROUTE # 1 (NAME: 1)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/--- PICKUP		L\U	PREV STOP DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	(BOX) (	)	TIM MIN	TIME HR:MN	DIST MILE
29	STOP35	WPAFB	OH	2	7:33A	0:00	30	0 D	40	0:03	1
36	STOP8	WPAFB	OH	2	8:16A	0:00	15	0 D	25	0:03	1
12	STOP2	WPAFB	OH	2	8:44A	0:00	5	0 D	15	0:03	1
9	STOP17	WPAFB	OH	2	9:02A	0:00	8	0 D	18	0:03	1
10	STOP18	WPAFB	OH	2	9:23A	0:00	13	0 D	23	0:03	1
13	STOP20	WPAFB	OH	2	9:49A	0:00	16	0 D	26	0:03	1
14	STOP21	WPAFB	OH	2	10:18A	0:00	20	0 D	30	0:03	1
	BACK TO DEPOT			2	10:51A					0:03	1
	TOTALS					0:00	107	0 D	177	0:24	8
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:24	HOURLY @ $ 13.52/HR.X2	45.29	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:57	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	107	0
				PICKUP	0	0
	3:21		45.29			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	8.00	DELIVER	89	0
				PICKUP	0	0
	0:00		8.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)		20
TOTAL TIME	3:21	TOTAL ROUTE COST	53.29			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

ROUTE # 2 (NAME: 2)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---			L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))		TIM MIN	DRV. TIME HR:MN	DIST MILE
34	STOP6	WPAFB	OH	2	7:37A	0:00	80	0	D	90	0:07	2
16	STOP23	WPAFB	OH	2	9:10A	0:00	11	0	D	21	0:03	1
19	STOP26	WPAFB	OH	2	9:34A	0:00	6	0	D	16	0:03	1
30	STOP36	WPAFB	OH	2	9:53A	0:00	1	0	D	11	0:03	1
	BACK TO DEPOT			2	10:07A						0:03	1
	TOTALS					0:00	98	0	D	138	0:19	6
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)		
					(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:19	HOURLY @ $ 13.52/HR.X2	35.38	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:18	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	98	0
				PICKUP	0	0
	2:37		35.38			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	6.00	DELIVER	82	0
				PICKUP	0	0
	0:00		6.00			
		DROP COST: @ $ 0.00/STOP	0.00			
				AVERAGE SPEED (MPH)		19
TOTAL TIME	2:37	TOTAL ROUTE COST	41.38			

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   LEASEWAY TECHNOLOGY CORP.                                        ROUTEASSIST 08/03/93
                                                                               11:05 AM
                                  ROUTE #    3 (NAME:   3       )

                                     *** SCHEDULE ***

     A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB   ,OH  WITH TRUCK
     CATEGORY  1 (1 1/2 TON ) AT  7:30 AM, DAY  2.

       ARRIVE AT STOPS                                                       PREV STOP
--------------------------------------        ---DELIVERY/---  L\U  DRV.
NO. ID          CITY         ST DAY TIME   WAIT   PICKUP           TIM  TIME   DIST
                                           HR:MN  (BOX      )      MIN  HR:MN  MILE
                                                   (          )
 32 STOP4        WPAFB       OH  2  7:37A  0:00    69        0 D    79   0:07     2
 11 STOP19       WPAFB       OH  2  8:59A  0:00    20        0 D    30   0:03     1
   BACK TO DEPOT                 2  9:32A                                0:03     1
                                           -----  -----  -----     ---  -----  -----
   TOTALS                                  0:00    89        0 D   109   0:13     4
                                                    0        0 P

          (#) : THESE DISTANCES CALCULATED BY ROUTEASSIST


                                   *** ANALYSIS ***

--- ROUTE TIMING --- --------- ROUTE COSTING ---------- ----- VEH DETAILS -----
                                                             (BOX      )
ON DUTY HOURS:       DRIVER COST:                                 (          )
 DRIVING       0:13   HOURLY  @ $ 13.52/HR.X2  27.49    VEH.CAP.   120       120
 WAITING       0:00   OVERTIM @ $ 20.28/HOUR    0.00
 UNLOAD        1:49   LAYOVER @ $ 50.00/LAY     0.00     DELIVER    89         0
             ------                           ------     PICKUP      0         0
               2:02                              27.49

OFF DUTY HOURS:      VEHICLE COST:                      VEHICLE UTILIZATION (%)
 LUNCH         0:00   FIXED                     0.00
 LAYOVER( 0)   0:00   MILEAGE @ $1.0000/MILE    4.00     DELIVER    74         0
             ------                           ------     PICKUP      0         0
               0:00                              4.00
                     DROP COST: @ $   0.00/STOP  0.00
             ------                           --------- AVERAGE SPEED (MPH)   18
TOTAL TIME     2:02  TOTAL ROUTE COST           31.49
```

LEASEWAY TECHNOLOGY CORP.   ROUTEASSIST 08/03/93
11:05 AM

ROUTE # 4 (NAME: 4)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV STOP	
										DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))	TIM MIN	TIME HR:MN	DIST MILE
2	STOP10	WPAFB	OH	2	7:37A	0:00	57	0 D	67	0:07	2
33	STOP5	WPAFB	OH	2	8:47A	0:00	60	0 D	70	0:03	1
	BACK TO DEPOT			2	10:04A					0:07	2
	TOTALS					0:00	117	0 D	137	0:17	5
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS -----		
					(BOX (	))
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:17	HOURLY @ $ 13.52/HR.X2	34.70	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:17	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	117	0
	------		-------	PICKUP	0	0
	2:34		34.70			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	5.00	DELIVER	98	0
	------		-------	PICKUP	0	0
	0:00		5.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)		18
TOTAL TIME	2:34	TOTAL ROUTE COST	39.70			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:05 AM

ROUTE # 5 (NAME: 5)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK
CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---		L\U	PREV DRV.	STOP
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX (	))	TIM MIN	TIME HR:MN	DIST MILE
1	STOP1	WPAFB	OH	2	7:33A	0:00	27	0 D	37	0:03	1
6	STOP14	WPAFB	OH	2	8:13A	0:00	12	0 D	22	0:03	1
3	STOP11	WPAFB	OH	2	8:38A	0:00	3	0 D	13	0:03	1
4	STOP12	WPAFB	OH	2	8:54A	0:00	77	0 D	87	0:03	1
	BACK TO DEPOT			2	10:28A					0:07	2
	TOTALS					0:00	119	0 D	159	0:19	6
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:19	HOURLY @ $ 13.52/HR.X2	40.11	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:39	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	119	0
	------		-------	PICKUP	0	0
	2:58		40.11			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	6.00	DELIVER	99	0
	------		-------	PICKUP	0	0
	0:00		6.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)		19
TOTAL TIME	2:58	TOTAL ROUTE COST	46.11			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11:05 AM

ROUTE # 6 (NAME: 6)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS						---DELIVERY/---		L\U	PREV STOP	
NO. ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)	TIM MIN	DRV. TIME HR:MN	DIST MILE
37 STOP9	WPAFB	OH	2	7:37A	0:00	84	0 D	94	0:07	2
BACK TO DEPOT			2	9:18A					0:07	2
TOTALS					0:00	84 0	0 D 0 P	94	0:14	4

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)		
ON DUTY HOURS:		DRIVER COST:			(	)
DRIVING	0:14	HOURLY @ $ 13.52/HR.X2	24.34	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:34	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	84	0
	------		-------	PICKUP	0	0
	1:48		24.34			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	4.00	DELIVER	70	0
	------		-------	PICKUP	0	0
	0:00		4.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)		17
TOTAL TIME	1:48	TOTAL ROUTE COST	28.34			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

ROUTE # 7 (NAME: 7)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	---DELIVERY/--- PICKUP (BOX) (	)		L\U TIM MIN	PREV STOP DRV. TIME HR:MN	DIST MILE
25	STOP31	WPAFB	OH	2	7:33A	0:00	55	0	D	65	0:03	1
27	STOP33	WPAFB	OH	2	8:41A	0:00	63	0	D	73	0:03	1
	BACK TO DEPOT			2	9:57A						0:03	1
	TOTALS					0:00	118	0	D	138	0:09	3
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		---------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:09	HOURLY @ $ 13.52/HR.X2	33.12	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:18	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	118	0
	2:27		33.12	PICKUP	0	0
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	3.00	DELIVER	98	0
	0:00		3.00	PICKUP	0	0
		DROP COST: @ $ 0.00/STOP	0.00			
TOTAL TIME	2:27	TOTAL ROUTE COST	36.12	AVERAGE SPEED (MPH)	20	

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

ROUTE # 8 (NAME: 8)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS						---DELIVERY/---			L\U	PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)	TIM MIN	DRV. TIME HR:MN	DIST MILE
17	STOP24	WPAFB	OH	2	7:53A	0:00	20	0 D	30	0:23	7
35	STOP7	WPAFB	OH	2	8:46A	0:00	65	0 D	75	0:23	7
	BACK TO DEPOT			2	10:04A					0:03	1
	TOTALS					0:00	85	0 D	105	0:49	15
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:49	HOURLY @ $ 13.52/HR.X2	34.70	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:45	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	85	0
	-------		-------	PICKUP	0	0
	2:34		34.70			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	15.00	DELIVER	71	0
	-------		-------	PICKUP	0	0
	0:00		15.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	-------		--------	AVERAGE SPEED (MPH)	18	
TOTAL TIME	2:34	TOTAL ROUTE COST	49.70			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

ROUTE # 9 (NAME: 9)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/--- PICKUP (BOX)			L\U	PREV STOP DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	(	)		TIM MIN	TIME HR:MN	DIST MILE
15	STOP22	WPAFB	OH	2	7:33A	0:00	20	0	D	30	0:03	1
21	STOP28	WPAFB OH	OH	2	8:06A	0:00	10	0	D	20	0:03	1
22	STOP29	WPAFB	OH	2	8:29A	0:00	55	0	D	65	0:03	1
23	STOP3	WPAFB	OH	2	9:37A	0:00	10	0	D	20	0:03	1
24	STOP30	WPAFB	OH	2	10:00A	0:00	15	0	D	25	0:03	1
26	STOP32	WPAFB	OH	2	10:28A	0:00	1	0	D	11	0:03	1
	BACK TO DEPOT			2	10:42A						0:03	1
	TOTALS					0:00	111	0	D	171	0:21	7
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:21	HOURLY @ $ 13.52/HR.X2	43.26	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:51	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	111	0
	------		-------	PICKUP	0	0
	3:12		43.26			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	7.00	DELIVER	93	0
	------		-------	PICKUP	0	0
	0:00		7.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)	20	
TOTAL TIME	3:12	TOTAL ROUTE COST	50.26			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

ROUTE # 10 (NAME: R0001)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/--- PICKUP			L\U	PREV STOP DRV.	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	(BOX)	( )		TIM MIN	TIME HR:MN	DIST MILE
5	STOP13	WPAFB	OH	2	7:37A	0:00	100	0	D	110	0:07	2
7	STOP15	WPAFB	OH	2	9:30A	0:00	2	0	D	12	0:03	1
8	STOP16	WPAFB	OH	2	9:45A	0:00	16	0	D	26	0:03	1
	BACK TO DEPOT			2	10:14A						0:03	1
	TOTALS					0:00	118	0	D	148	0:16	5
							0	0	P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:16	HOURLY @ $ 13.52/HR.X2	36.95	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:28	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	118	0
	------		-------	PICKUP	0	0
	2:44		36.95			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	5.00	DELIVER	98	0
	------		-------	PICKUP	0	0
	0:00		5.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)	19	
TOTAL TIME	2:44	TOTAL ROUTE COST	41.95			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93
11 05 AM

ROUTE # 11 (NAME: R0002)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV STOP
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)	L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
18	STOP25	WPAFB	OH	2	7:33A	0:00	70	0 D	80	0:03	1
20	STOP27	WPAFB	OH	2	8:56A	0:00	49	0 D	59	0:03	1
BACK TO DEPOT				2	9:58A					0:03	1
TOTALS						0:00	119	0 D	139	0:09	3
							0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ----------		----- VEH DETAILS -----		
					(BOX) (	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:09	HOURLY @ $ 13.52/HR.X2	33.35	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	2:19	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	119	0
	------		-------	PICKUP	0	0
	2:28		33.35			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	3.00	DELIVER	99	0
	------		-------	PICKUP	0	0
	0:00		3.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)	20	
TOTAL TIME	2:28	TOTAL ROUTE COST	36.35			

LEASEWAY TECHNOLOGY CORP. ROUTEASSIST 08/03/93 11:05 AM

ROUTE # 12 (NAME: R0003)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS							---DELIVERY/---				PREV STOP	
NO.	ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX)	( )		L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
28	STOP34	WPAFB	OH	2	7:33A	0:00	72	0	D	82	0:03	1
	BACK TO DEPOT			2	8:58A						0:03	*
	TOTALS					0:00	72	0	D	82	0:06	2
							0	0	P			

(*) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		----- VEH DETAILS ----- (BOX)	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:06	HOURLY @ $ 13.52/HR.X2	19.83	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:22	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	72	0
	------		-------	PICKUP	0	0
	1:28		19.83			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	2.00	DELIVER	60	0
	------		-------	PICKUP	0	0
	0:00		2.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)		20
TOTAL TIME	1:28	TOTAL ROUTE COST	21.83			

ROUTE # 13 (NAME: R0004)

*** SCHEDULE ***

A SLEEPER TEAM SHOULD LEAVE DEPOT 645 TRNS/LGTTB ,OH WITH TRUCK CATEGORY 1 (1 1/2 TON) AT 7:30 AM, DAY 2.

ARRIVE AT STOPS						---DELIVERY/---			PREV STOP	
NO. ID	CITY	ST	DAY	TIME	WAIT HR:MN	PICKUP (BOX) (	)	L\U TIM MIN	DRV. TIME HR:MN	DIST MILE
31 STOP37	WPAFB	OH	2	7:40A	0:00	70	0 D	80	0:10	3
BACK TO DEPOT			2	9:10A					0:10	3
TOTALS					0:00	70	0 D	80	0:20	6
						0	0 P			

(#) : THESE DISTANCES CALCULATED BY ROUTEASSIST

*** ANALYSIS ***

--- ROUTE TIMING ---		--------- ROUTE COSTING ---------		----- VEH DETAILS (BOX) -----	(	)
ON DUTY HOURS:		DRIVER COST:				
DRIVING	0:20	HOURLY @ $ 13.52/HR.X2	22.53	VEH.CAP.	120	120
WAITING	0:00	OVERTIM @ $ 20.28/HOUR	0.00			
UNLOAD	1:20	LAYOVER @ $ 50.00/LAY	0.00	DELIVER	70	0
	------		-------	PICKUP	0	0
	1:40		22.53			
OFF DUTY HOURS:		VEHICLE COST:		VEHICLE UTILIZATION (%)		
LUNCH	0:00	FIXED	0.00			
LAYOVER(0)	0:00	MILEAGE @ $1.0000/MILE	6.00	DELIVER	58	0
	------		-------	PICKUP	0	0
	0:00		6.00			
		DROP COST: @ $ 0.00/STOP	0.00			
	------		--------	AVERAGE SPEED (MPH)		18
TOTAL TIME	1:40	TOTAL ROUTE COST	28.53			

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Vita

Captain Rex E. Adee was born on 30 October 1958 in Washington, Kansas. He graduated from North Central High School in 1976. He then enlisted in the U.S. Army and served three years as a radar technician. He then continued his studies at Bartlesville Wesleyan College in Bartlesville, Oklahoma graduating in 1984 with a Bachelor of Science in Business Administration. He then worked for Phillips Petroleum Company in Bartlesville, Oklahoma as a computer technician/programmer. In 1987, he attended Officer Training School and was commissioned a Second Lieutenant on July 22. Captain Adee's first assignment was at Moody AFB, Georgia where he served as OIC, Plans and Programs and Vehicle Maintenance Officer. From there he went to Osan AB, ROK where he was assigned to the 51st Transportation Squadron as Chief, Combat Readiness and Resources. He also served in the capacity as Traffic Management Officer while at Osan. In March 1991, he then became the Executive Officer to the Vice Commander, 7th Air Force. He attended Squadron Officers School enroute to entering the School of Logistics and Acquisition Management, Air Force Institute of Technology, in May 1992.

Permanent Address: 1305 S. Delaware
Bartlesville, Oklahoma 74003

Vita

Captain William G. Howard was born on 22 December 1961 in Cincinnati, Ohio. He graduated from St. Xavier High School in 1980. He continued his studies at Xavier University in Cincinnati, Ohio graduating in 1984 with a Bachelor of Science degree in Business Administration. He was commissioned as a Second Lieutenant through Reserve Officer Training Corps in 1984. Captain Howard's first assignment was at Ft Eustis, Virginia. There he served as a Platoon Leader, Executive Officer, and Purchasing Control Officer. Captain Howard was then assigned to the 53rd Transportation Battalion, 37th Transportation Command, Europe. There he served as an Assistant Operations Officer, Company Commander, and Battalion S-4. In 1992, Captain Howard entered the Air Force Institute of Technology, School of Logistics and Acquisition Management, as a Graduate Student in Logistics Management.

Permanent Address: 3806 Millsbrae Avenue
Cincinnati, Ohio 45209

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The purpose of this study is to determine if a commercial computerized vehicle routing program improves vehicle utilization for an Air Force base transportation organization. First, the researchers investigate current routing procedures of Air Force base transportation organizations. Second, researchers identify a commercial computerized vehicle routing program that enables the authors to conduct a comparison of vehicle utilization rates between an Air Force base transportation organization and commercial computerized vehicle routing programs.

The study reveals that implementing a computerized vehicle routing program in place of a manual routing procedure does not improve vehicle utilization. However, the study reveals some limitations that may affect the outcome. The study also provides suggestions for further research of vehicle routing programs in military applications.

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